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An Experience Economy Perspective

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# Determining Visitor Engagement through Augmented Reality at Science Festivals: An Experience Economy Perspective

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# Determining Visitor Engagement through Augmented Reality at Science Festivals: An Experience Economy Perspective

## Abstract

Augmented reality (AR) has been increasingly implemented to enhance visitor experiences, and tourism research has long understood the importance of creating memorable experiences, leading to the research era of experience economy. Although technology-enhanced visitor engagement is crucial for science festivals, research focusing on visitor engagement through AR using the experience economy perspective is limited. Therefore, the aim of this study is to examine how the educational, esthetics, escapist and entertainment experience using AR affect visitor satisfaction and memorable experience, and eventually, lead to visitor engagement with science experiences in the context of science festivals. A total of 220 data inputs were collected as part of the European City of Science festivities and Manchester Science Festival 2016 and analyzed using structural equation modelling. Findings show that the four realms of experience economy influence satisfaction and memory and, ultimately, the intention for visitor engagement with science research at science festivals. Theoretical contributions and practical implications are presented and discussed.

**Keywords:** Augmented reality, science festivals, visitor engagement, experience economy, satisfaction, memory

## 1. Introduction

Festivals are considered one of the key activities that boost visitor economy, and many cities around the world use festivals to attract visitors. According to Bultitude et al. (2014), science festivals are particularly common within Europe and a driver for international and domestic tourism activities. Research has shown that achieving visitor engagement is critical for any festival in order to be successful and sustainable (Stilgoe et al., 2014). In particular, “science festivals have expanded in size and number over the recent years as a form of public engagement” and “public engagement has become the new mantra” in Europe (Jensen & Buckley, 2014, p. 558). The main objectives of science festivals include the celebration of science and engaging of non-specialist audiences (Bultitude et al., 2014). Technology was found to be a solution in order to facilitate the engagement of visitors. One of the more recent technologies on the market is augmented reality (AR) which is the overlay of digital content into users’ immediate surroundings, “allowing users to explore the surrounding environment by using mobile technologies” (Georgiou & Kyza, 2017, p. 24). Benefits of AR in terms of visitor engagement, immersion, and education make it a promising technology to engage visitors in science as part of their visit to science festivals (Altimira et al., 2017; Georgiou & Kyza, 2017). In fact, the main criticism of science festivals from the perspective of visitor engagement are 1) that they often neglect underrepresented audiences, and 2) that they preach to the already converted, as visitors are generally well-educated and interested in the themes (Bultitude, 2014). In order to overcome these potential issues in relation to engagement activities, technology-enhanced visitor engagement is considered as crucial, particularly for science festivals (Stilgoe et al., 2014). New and emerging digital technologies, such as AR, have been used for the enhancement of visitor experiences (Moorhouse et al., 2017). However, there is only limited research on technology-enhanced visitor engagement using AR in the context of science festivals.

47  
48 Recently, research started to use the framework of the Experience Economy by Pine and Gilmore  
49 (1998) as a theoretical foundation to explore the effects of AR (Jung et al., 2016; Neuburger &  
50 Egger, 2017). It includes the four realms of experience, educational, esthetics, escapist and  
51 entertainment. This research direction is very valuable within the context of visitor economy  
52 considering the importance of enhancing the visitor experience through various forms of  
53 interaction in order to increase or sustain tourist numbers, enhance the level of engagement, and  
54 generate positive word-of-mouth to ensure future sustainability. Pine and Gilmore's Experience  
55 Economy model is considered to be the predominant framework within the subject area of visitor  
56 experiences (Jung et al., 2016). Rather than simply providing products and services, Pine and  
57 Gilmore (1998) emphasized the importance of staging experiences. Within the service-driven  
58 tourism domain, many scholars have supported the importance of tourist participation for the co-  
59 creation of value (Sorensen & Jensen, 2015).

60  
61 Although numerous scholars (e.g., Manthiou et al., 2014; Mehmetoglu and Engen, 2011; Oh et al.,  
62 2007) applied the Experience economy framework in other tourism and hospitality contexts,  
63 several limitations remain. First, prior research conceptualized the four dimensions as independent  
64 constructs or as a higher order constructs. In this study, we provide arguments for a process view.  
65 In particular, we argue that "the first impression matters" – that esthetics are the source of  
66 experience, resulting in an increase in educational, escapist and entertainment. Second, prior  
67 research has mostly applied experience economy to explain established constructs, such as loyalty  
68 (e.g. Manthiou et al.; 2014). This study complements prior research with a novel and managerially  
69 highly target construct: Visitor engagement. Finally, despite the general consensus that experience  
70 economy provides numerous advantages to media and tourism research, and scholars agree that  
71 science festivals are an important subject to study, empirical applications remain of experience  
72 economy remain scarce.

73  
74 In order to achieve the aim of this study we proposed a theoretical model grounded in the  
75 experience economy literature. To test the model, a total of 220 data were collected as part of the  
76 European City of Science festivities and Manchester Science Festival 2016 and analyzed using  
77 structural equation modelling. The findings offer a number of contributions to the literature. On  
78 the one hand, findings show that esthetics is a strong predictor of escapism, education, and  
79 entertainment within the AR science festival context. Therefore, this study shows that the  
80 experience economy concept in the context of AR applications does not consist of four  
81 independent dimensions. On the other hand, this study found that the remaining three realms of  
82 the experience economy influence visitors' satisfaction and memories of the AR science festival  
83 experience which ultimately influences visitors' engagement.

## 84 85 2. Theoretical Background

### 86 2.1 Augmented Reality and Visitor Experience

87 AR is the digital overlay of information into users' direct surroundings using devices such as  
88 smartphones or wearable smart glasses (Jung et al., 2015; Kalantari & Rauschnabel, 2017;  
89 Tussyadiah et al., 2017). AR is a source of technological innovation (Neuhofer et al., 2012); if  
90 implemented correctly, destinations can effectively obtain a competitive advantage and attract new  
91 markets (Tscheu and Buhalis, 2016). The creation of mobile AR is especially considered to be  
92 attractive, as visitors can use applications on their smartphones, reducing the barrier to engage and

93 adopt (Han et al., 2014). For example, visitors can hold their smartphone with an AR app against  
94 a building and receive relevant information. Likewise, visitors of museums can look at exhibits  
95 through an AR app and learn more about them. These two example applications reflect conclusions  
96 of prior research that this cutting-edge technology can enhance and add value to the overall visitor  
97 experience, provide a motivation to visit, and generate positive word-of-mouth (Morrison, 2013).  
98 At attractions, visitors can instantly access and unlock historic knowledge and reveal hidden  
99 stories, whilst avoiding interrupting or overcrowding the physical space (Molz, 2012). This  
100 effectively bridges the gap between exploring innovative technologies and personalized  
101 experiences, as visitors can tailor the experience and explore and discover personal points of  
102 interest (Neuhofer et al., 2015). In addition, the overlay of 2D and 3D graphics engages the user  
103 (Wu et al., 2013) and encourages new and innovative ways of learning (Moorhouse et al., 2017).  
104 Overall, AR can enhance the attractiveness of destinations when marketed effectively by  
105 destination management organisations (Tscheu and Buhalis, 2016), as it can create a unique and  
106 memorable experience for visitors (Jung and tom Dieck, 2017). Nevertheless, according to  
107 Rauschnabel et al. (2017), AR acceptance remains a challenge and is under-researched, and must  
108 be overcome by lower complexities in the design and implementation process (Wu et al., 2013).

109

## 110 2.2 Experience Economy

111 To understand AR, researchers have applied numerous theories in different study contexts. Studies  
112 with a focus on the device itself have applied technology acceptance theories (e.g. Rauschnabel &  
113 Ro, 2016). In contrast, other research has highlighted a theoretical framework termed ‘experience  
114 economy’ (Pine & Gilmore, 1998). Research has long understood the importance of creating  
115 memorable experiences (Kang & Gretzel, 2012; Park et al., 2010; Quan & Wang, 2004) and,  
116 therefore, the move from the service economy to the experience economy comes as no surprise  
117 (Knutson et al., 2010).

118

119 The initial idea of the experience economy proposed four realms of consumer experiences based  
120 on two dimensions: involvement, ranging from passive to active participation of the consumer,  
121 and the desire, ranging from absorption to immersion, within which a consumer engages with a  
122 consumption object. The experience economy suggests that there are four realms of an experience,  
123 as displayed in Figure 1, which can be classified by a spectrum of connection (immersion and  
124 absorption) along the vertical, and a spectrum of participation (active and passive) along the  
125 horizontal line of the model (Pine & Gilmore, 1998). According to Quadri-Felitti and Fiore (2013,  
126 p. 48), “active participation is where customers personally affect the performance or event, and  
127 passive participation is where customers do not directly affect or influence the performance. In  
128 addition, immersion is described as becoming physically or virtually enveloped by the event [...] whereas  
129 absorption involves engaging the consumer’s mind”.

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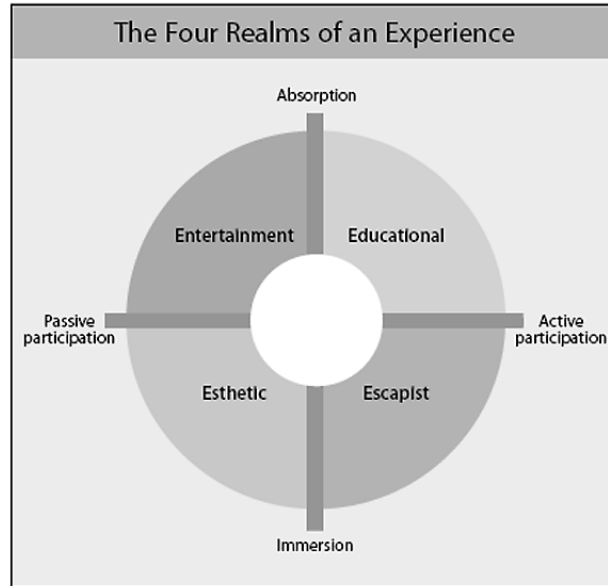


Fig. 1. Experience Economy (Pine & Gilmore, 1998)

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Within the educational realm, visitors are actively engaged in tourism activities to gain new skills and knowledge (Oh et al., 2007). A number of previous studies have confirmed the role of AR as an effective tool for education, supporting its strength in creating interactive content that is easy to remember (e.g. Moorhouse et al., 2017; tom Dieck et al., 2016). As part of the entertainment experience, Jung et al. (2016) proposed that users utilize applications for an enjoyable experience. Based on the Experience Economy model, this enjoyable and entertaining experience is in the form of a more passive delivery of content (e.g. movies). Escapism is the third realm of experience and refers to visitors' active participation in the delivery of products and services as well as visitors' willingness to momentarily forget happenings within their normal lives by fully immersing in the experience (Song et al., 2015). Finally, esthetics were originally proposed to reflect visitors' full immersion within an experience that does not interact with them (Pine & Gilmore, 1998). Considering the importance of immersion as part of an AR experience, Jung et al. (2016) argued that escapism and esthetics become increasingly more important with the emergence of AR applications. Scholars from various disciplines have adopted the idea and applied it to numerous contexts (see Table 1).

Study	Research Question/Aim	Context	Sample and Methods	Conceptualization of Experience Economy	Findings relevant to the study context / this study's contribution
Hosany & Witham (2009)	Development of a measurement scale for tourist experience	Cruise Tourism	N=169, Confirmatory factor analysis and regression analysis	On one level	The study provides a measurement scale for the experience economy dimension. Results generally reveal homological validity
Jung et al. (2016)	Explore if experience could be enhanced by social presence in the mixed reality environment and further inducing revisit intention to visitor attraction	AR and VR in Museums	N=163, PLS	On one level	Social presence impact experience economy constructs Only Education and Entertainment drive the overall tour experience

Loureiro (2014)	Explore the effect of Experience economy on place attachment and intention	Rural tourism	N=222., PLS	Higher order construct	The correlation matrix suggests that the strength of the experiences differ between target constructs, indicating that each dimension behaves differently in the context.
Manthiou et al. (2014)	Explore visitor experiences to understand future behaviour	Festival Marketing	N=338, SEM	On one level	Four experience realms result in an optimal experience, influencing vividity as a mediating and loyalty as a dependent variable.
Mehmetoglu & Engen (2011)	Explore how different experiential dimensions influence satisfaction	Museum and Festival	N=75 and N=117, PLS SEM,	On one level	Mixed findings depending on the context and target variable
Oh et al. (2007)	Development of a scale and assessing its nomological validity	Hotel industry	N=419, CFA and correlation	On one level	Measurement scale that is correlated with Arousal, Memory, Quality, and Satisfaction; no regression-based results are presented.
This study	Explore the effect of AR experience influence on visitors' engagement with science experience	AR for science festivals	N= 220, SEM	Mediating structure, where esthetics drive entertainment, education and escape, which the subsequently impact outcome variables	We show that experience economy constructs are not independent from each other, but represent a networked structure. Experience economy constructs play an important role in explaining visitors' reactions on AR apps

150 Table 1. Summary of previous studies

151  
 152 While the flexibility is a major strength of the experience economy framework, it is also associated  
 153 with a number of concerns, ranging from criticism on the conceptualization to lack of measurement  
 154 challenges. While addressing the measurement challenges of each of the four experiences have  
 155 been subject to numerous studies (e.g. Oh et al., 2007; Hosany & Witham, 2009), the overall  
 156 conceptualization provides some unanswered questions. For example, whereas Pine and Gilmore  
 157 (1998) argued that the interaction of two dimensions, involvement and desire, are sufficient to  
 158 generate four types of experience, other studies, especially in the tourism context, have found that  
 159 each of the four experiences should either serve as individual dimensions, or be treated as a higher-  
 160 order construct (e.g. Loureiro, 2014). However, as shown in Table 1, studies that compared the  
 161 effects of each of the four constructs on target variables often concluded that only a few of them  
 162 matter. An inspection of the correlations between the factors indicates meaningful correlations  
 163 between all four variables, indicating that – contrary to Pine and Gilmore (1998)'s framework –  
 164 the four constructs are not independent of each other. [This study aims to extend prior research on](#)  
 165 [experience economy in several ways.](#)

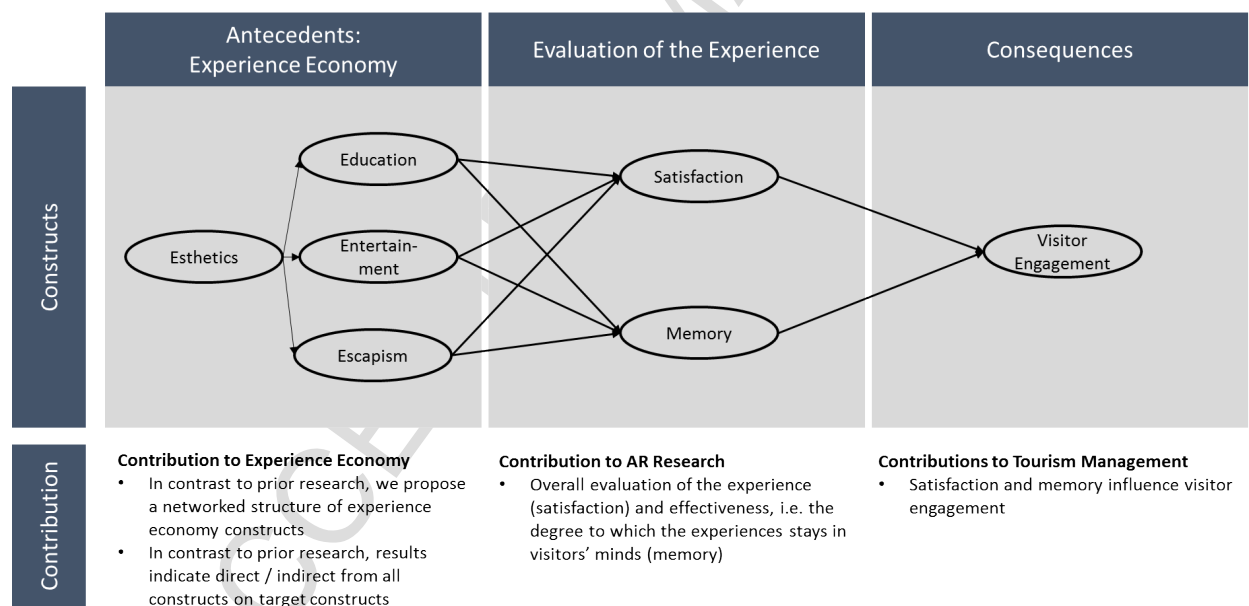
166  
 167 [As presented in Table 1, the majority of studies \(Hosany & Witham, 2016; Jung et al., 2016;](#)  
 168 [Mehmetoglu & Engen, 2011; Oh et al., 2007\) tested the experience economy constructs on one](#)  
 169 [level and supported the effects of all or some of the four constructs on the experience within](#)  
 170 [various tourism-related contexts. For instance, Jung et al. \(2016\) failed to find a significant relation](#)  
 171 [of esthetics onto the overall experience, raising the question of the appropriateness of seeing or](#)

172 applying each construct on one level. In addition, none of the studies incorporated the effects of  
 173 the experience economy constructs on satisfaction, memory and ultimately visitor engagement.  
 174

175 Thus, the aim of this study is to address this gap in the literature as follows. First, this study aims  
 176 to apply the experience economy framework to investigate factors relating to visitor engagement  
 177 in the context of science festivals. Second, this research assesses the mediation effects of memory  
 178 and satisfaction in the experience economy – engagement relationship. Finally, this study proposes  
 179 a novel view on the interplay of the experience economy constructs. Rather than stating that each  
 180 of the four realms is independent from each other or that all together reflect a higher order construct,  
 181 we propose a mediating structure.  
 182

### 183 3. Proposed Model

184 Figure 2 shows the basic theoretical framework of this study. First, we propose that visitors' actual  
 185 use of an AR device triggers the constructs of the experience economy framework, whereas – in  
 186 contrast to prior research (see Table 1) – we provide a more nuanced relationship between the four  
 187 constructs. Second, we propose that experience economy constructs determine visitors' overall  
 188 evaluation of the on-site AR experience. In particular, we propose that the experience economy  
 189 serves how much people enjoyed using the AR experience (satisfaction), but also to what extent  
 190 the experience stays in their mind (memory). Third, the model proposes that satisfaction and  
 191 memory both impact visitor engagement, a crucial, yet under-researched, construct in tourism  
 192 research.  
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195  
 196 Fig. 2. Proposed Model  
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#### 198 3.1 Experience Economy

199 Research in numerous domains has shown that visible cues are the first cues that people use to  
 200 make judgments about people and things. For example, when interacting with other people,  
 201 physical cues (e.g. face, cloths etc.) are among the first cues people use to judge a persona, such  
 202 as sympathetic, smart, etc. Similarly, when using a new software, one of the first users incorporate



203 into their decision making is the design of the user interface. We argue that this general finding is  
204 also relevant in the creating of visitor experience.

205 In a related context, Pallud and Straub (2014) show that aesthetics represent the most important  
206 criteria for interface development, which ultimately dictates whether visitors accept or reject latest  
207 technologies. In particular, especially when technologies become more immersive, both Jung et al  
208 (2016) and Lee et al. (2015) argue that interface design becomes even more relevant than in less  
209 immersive contexts. Tourism scholars, such as Hosany and Witham (2009) or Mykletun & Rumba  
210 (2014) even argue that esthetics are among the most important drivers within the experience  
211 economy. Likewise, Jung et al. (2018)'s cross-cultural study on AR concludes that esthetics are  
212 particularly relevant since it can compensate for technological limitations of many current AR  
213 devices. Consequently, this means that if esthetics of an experience are low, the educational,  
214 entertainment, and escapism experiences are likely to suffer. On the other hand, once users are  
215 exposed to a favourable esthetics experience, this should translate to higher levels of education  
216 (H1a), entertainment (H1b) and escapism (H1c) dimension. This is a different conceptualization  
217 of most prior studies (see table 1). In particular, most prior studies implicitly assume, for example,  
218 that users rate the escapism value of apps independently of their esthetic experience. Simplified  
219 speaking, this would imply that the escapism experience would not suffer if an app was poorly  
220 designed (Jung et al., 2018). This assumption would also imply that poorly designed apps provide  
221 the same educational and entertainment experience than well-designed ones, assumptions that  
222 prior theory and reported correlations might question. Thus, we propose esthetics as a determinant  
223 of the remaining three experience constructs and, thus, the following is hypothesized:

224  
225 H1a: Esthetics has a positive effect on education.

226 H1b: Esthetics has a positive effect on entertainment.

227 H1c: Esthetics has a positive effect on escapism.

228

### 229 3.2 Experience Economy and Satisfaction

230 According to Srivastava and Kaul (2014, p. 1028), satisfaction can be defined as “consumer  
231 judgment that a product or service provides a pleasurable level consumption-related fulfilment”,  
232 which has long been discussed as an important determinant of behavioral intentions within  
233 technology adoption research (e.g. tom Dieck et al., 2017). According to Mehmetoglu and Engen  
234 (2011), experiences allow people to draw upon the events to paint a picture of their lives. They  
235 allow for an evaluation of an individual's perception of his or her self-image, which is the  
236 aggregation of his or her lifetime experiences. Following this logic, Mehmetoglu and Engen (2011)  
237 argued that individual experiences are highly important for consumers' views and satisfaction of  
238 products or services. Furthermore, as part of the experience economy, there has been sufficient  
239 evidence of strong impacts of the realms of experience economy on satisfaction. For instance, the  
240 effect of education and entertainment onto tourist satisfaction within the film festival context was  
241 supported by Park et al. (2010), and Quadri-Felitti and Fiore (2013) confirmed that education  
242 strongly affects satisfaction within the tourism context. Consequently, this study proposed that:

243

244 H2a: Education has a positive effect on satisfaction.

245 H2b: Entertainment has a positive effect on satisfaction.

246 H2c: Escapism has a positive effect on satisfaction.

247

### 248 3.3 Experience Economy and Memory

249 Studies have long acknowledged the importance of experiencing events and the consequent  
250 creation of memories (Pine & Gilmore, 1998). In fact, das Gupta et al. (2016, p. 1278) revealed  
251 “for many consumer-intensive (B2C) services, delivering memorable customer experiences is a  
252 source of competitive advantage”. According to Manthiou et al. (2014), an experience involves  
253 the input of information into the sensory system of an individual’s brain. Consequently, a memory  
254 is what remains of an event after the sensory experience occurred, making it an integral part of any  
255 experience framework.

256  
257 In the context of the experience economy, it is, therefore, proposed that the experiences is  
258 considered the cause, and the memory is considered the effect (Manthiou et al., 2014). This was  
259 confirmed by Pine and Gilmore (1998), who revealed that an optimal experience should lead to  
260 enhanced memories. Kahneman (2011, p. 388) strengthened that “tourism is about helping people  
261 construct stories and collect memories”. This was supported by Ali et al. (2014), who found that  
262 tourists’ experiences revolving around the four realms of the experience economy result in strong  
263 memories and positive behaviors. Similar findings were determined in other tourism contexts, as  
264 Loureiro (2014) as well as Quadri-Felitti and Fiore (2013) tested the effect of experience economy  
265 onto memory within the festival and wine tourism context, and found that the educational  
266 experience significantly influenced memory. Entertainment was found to significantly influence  
267 memory by Mykletun and Rumba (2014). Therefore, it is proposed that:

268  
269 H3a: Education has a positive effect on memory.

270 H3b: Entertainment has a positive effect on memory.

271 H3c: Escapism has a positive effect on memory.

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### 273 3.4 Satisfaction, Memory, and Visitor Engagement

274 It has been well-recognized that satisfaction and positive memories influence behavioral intentions  
275 within technology adoption literature (Wixom & Todd, 2005), particularly within the tourism  
276 context (Ali et al., 2014; Ali et al., 2016; Hosany & Witham, 2009; tom Dieck et al., 2017).  
277 However, the direct comparison of these two crucial concepts, as well as their interaction, remains  
278 an under-researched area. As we propose and empirically validate, maximising both concepts  
279 might – counterintuitively – not be a desired strategy for tourism managers. There are several ways  
280 to measure behavioral intention within the technology adoption research stream. A number of  
281 studies have focused on the intention to use technology that is relatively new on the market  
282 (Rauschnabel & Ro, 2016), continued usage intentions (tom Dieck et al., 2017), intention to  
283 recommend (Prayag et al., 2017) or loyalty (Valle et al., 2006). However, studies focusing on the  
284 intention for visitor engagement is scarce, and the overall area is highly under-researched.  
285 Nevertheless, as previously discussed, visitor engagement with particular themes within a  
286 destination can be considered extremely valuable in order to provide a unique, educational, and  
287 memorable visitor experience. Thus, we propose:

288

289 H4: Satisfaction has a positive effect on visitor engagement.

290 H5: Memory has a positive effect on visitor engagement.

291

## 292 4. Methods

### 293 4.1 Study context

294 The study was conducted as part of the European City of Science (ECOS) festivities and  
295 Manchester Science Festival in Manchester, UK, in 2016. Among other ECOS initiatives, a mobile  
296 AR application (see Fig. 3) was developed in order to provide visitors to Manchester with an  
297 enhanced experience. In particular, the app provided information on ECOS events and the history  
298 of science in Manchester. Furthermore, one of the functionalities of the application was related to  
299 AR. iBeacons were located around the city centre, and whenever a visitor walked near a beacon,  
300 the app notified him about the opportunity to learn something new about Manchester science when  
301 scanning a certain object. These objects varied from statues to buildings or simply plaques. Once  
302 a visitor located and scanned such an object, information in form of audio, video, animation (see  
303 Fig. 4 Pokémon animation of scientist Prof. Brian Cox), or text were overlaid into visitors'  
304 immediate surroundings, representing the AR element of the application.  
305



Fig. 3. ECOS Mobile Application

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#### 4.2 Data Collection

311 Questionnaires were collected as part of the ECOS festivities and Manchester Science Festival  
312 between July and December 2016. Data were collected from visitors who experienced the mobile-  
313 based AR application in the city centre of Manchester as part of their visit to the city. It is important  
314 to note that these tourists did not actively attend the science festival, but were visiting Manchester  
315 during the period. Random sampling was used and a total of 220 usable data inputs were collected.  
316 Shenton (2004) revealed that a random sampling technique increased the representativeness of a  
317 sample, as it includes the opinion of a general population rather than a selected sample. The  
318 researchers approached every 10<sup>th</sup> visitor as part of the random sampling technique in front of the  
319 Central Library, one of the major squares of the city and a focal visitor point for tourists coming  
320 to Manchester. Prior to participation, participants were asked if they were tourists in Manchester,  
321 and only those confirming were selected. The study was designed as a science tour and prior to  
322 filling in questionnaires, tourists were asked to experience four different sites, including buildings,  
323 monuments, or statues in close proximity that provided AR content, triggered by iBeacons. The  
324 average tour lasted approximately 30 minutes. Participants were provided with Android phones  
325 and a map that showed AR-enabled sites by the researcher in order to ensure that every participant  
326 had the same experience. However, all the participants took part in the tour on their own.  
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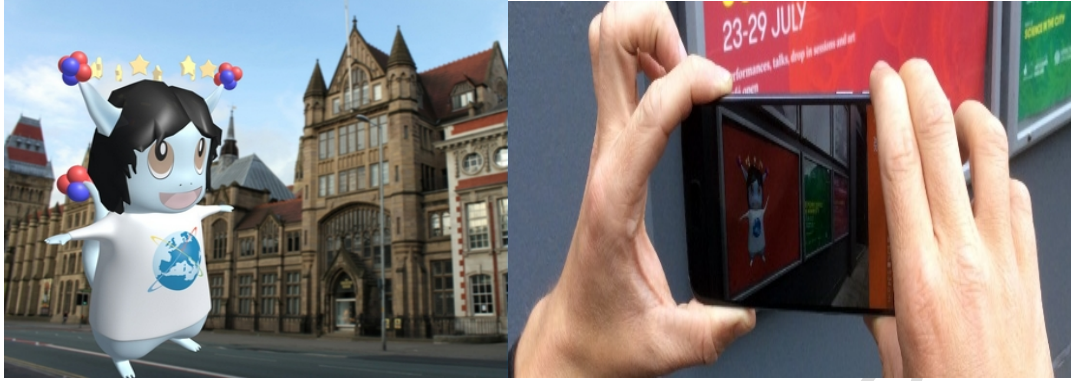


Fig. 4. Animation within AR application

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## 5. Results

### 5.1 Profile of Participants

Participants' profiles are shown in Table 2. There were slightly more males (56.4%) than females (43.6%). The majority of respondents was aged between 18 and 24. Almost half of participants had an undergraduate degree (45.5%), followed by postgraduate degree (27.7%) and A-levels (16.4%). With regards to income level, less than £20,000 was mostly represented (51.8%), and more than half of respondents were students (57.3%).

Characteristics	N	%	Characteristics	N	%
<b>Gender</b>			<b>Income</b>		
Male	124	56.4	Less than £20,000	114	51.8
Female	96	43.6	£20,000-£40,000	66	30.0
<b>Age</b>			£40,000-£60,000	24	10.9
18-24	128	58.2	£60,000-£80,000	9	4.1
25-34	54	24.5	£80,000-£100,000	0	0.0
35-44	16	7.3	£100,000+	7	3.2
45-54	15	6.8	<b>Occupation</b>		
55-64	4	1.8	Full-time employed	74	33.6
65+	3	1.4	Part-time employed	15	6.8
<b>Education</b>			Self-employed	3	1.4
No Formal Qualification	4	1.8	Housewife/husband	0	0.0
GCSE/O-level	4	1.8	Unemployed	2	0.9
A-level	36	16.4	Retired	0	0.0
Undergraduate Degree	100	45.5	Student	126	57.3
Postgraduate Degree	61	27.7			
Doctoral Degree	13	5.9			
Professional Degree	2	0.9			
			<b>Total</b>	220	100%

Table 2. Participants Profile

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### 5.2 Measures

All constructs (see appendix for definitions) were measured by three to four measurement items and ranked on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The measurement items were adapted from established reflective multi-item construct scales from previous literature (Loureiro, 2014; Manthiou et al., 2014; Mehmetoglu & Engen, 2011; Oh et al., 2007; Quadri-Felitti & Fiore, 2013). We inspected the psychometric characteristics of the measurement instrument using a series of exploratory and confirmatory factor analysis. Although

349 the  $\chi^2$ -value of 350.2 (df=209) was significant ( $p<.001$ ), the  $\chi^2/df$  ratio of 1.7 was lower than 4 and,  
 350 thus, acceptable. In addition, the model fit (CFI=.95; TLI=.94; RMSEA=.06; SRMR=.05) reflects  
 351 absence of substantial approximation errors and shows no substantial differences between  
 352 observed and predicted correlation matrices. Then, we, assessed the psychometric characteristics  
 353 on a construct level. As shown in Table 3, all factor loadings are significant ( $p<.001$ ) and above .70.  
 354 In addition, Cronbach's alpha ( $\alpha$ ), Composite Reliability (CR), and Average Variance Extracted  
 355 (AVE) exceeded the recommended threshold of .7, .7, and .5, respectively. We assessed  
 356 discriminant validity using the Fornell and Larcker (1981) procedure. Evidence of discriminant  
 357 validity exists in the study, as AVE values all are above the squared construct correlations (Hair  
 358 et al., 2006) (see Table 4).  
 359

Constructs and Items	Mean	SD	CR	AVE	$\alpha$
<b>Esthetics</b> (Loureiro, 2014; Manthiou et al., 2014; Mehmetoglu & Engen, 2011; Oh et al., 2007; Quadri-Felitti & Fiore; 2013)			0.83	0.63	0.83
The setting of the AR experience was very attractive	0.74	3.80	0.97		
The AR experience was very pleasant	0.87	3.84	0.85		
I felt a real sense of harmony	0.77	3.35	0.97		
<b>Education</b> (Loureiro, 2014; Manthiou et al., 2014; Mehmetoglu & Engen, 2011; Oh et al., 2007; Quadri-Felitti & Fiore; 2013)			0.87	0.63	0.87
I learned something new during the AR experience	0.77	3.90	1.03		
The experience made me more knowledgeable	0.76	3.75	1.03		
It stimulated my curiosity to learn new things	0.78	3.86	0.95		
It was a real learning experience	0.84	3.75	0.99		
<b>Entertainment</b> (Manthiou et al., 2014; Mehmetoglu & Engen, 2011; Oh et al., 2007; Quadri-Felitti & Fiore; 2013)			0.87	0.70	0.87
The AR experience was amusing	0.76	3.83	0.97		
The AR experience was entertaining	0.83	3.94	0.92		
The AR experience was fun	0.91	3.91	0.93		
<b>Escapism</b> (Loureiro, 2014; Manthiou et al., 2014; Mehmetoglu & Engen, 2011; Oh et al., 2007; Quadri-Felitti & Fiore; 2013)			0.92	0.73	0.92
I felt I played a different character when using the AR application	0.86	2.73	1.19		
I felt like I was living in a different time or place	0.83	2.71	1.19		
The AR experience let me imagine being someone else	0.92	2.59	1.23		
I completely escaped from reality	0.82	2.42	1.16		
<b>Memories</b> (Loureiro, 2014; Oh et al., 2007; Quadri-Felitti & Fiore; 2013)			0.90	0.75	0.89
I will have wonderful memories about this AR experience	0.86	3.36	1.02		
I won't forget my experience of this AR experience	0.83	3.44	1.04		
I will remember many positive things about this AR experience	0.90	3.59	0.97		
<b>Satisfaction</b> (Mehmetoglu & Engen, 2011; Quadri-Felitti & Fiore; 2013)			0.87	0.70	0.87
I was satisfied with the overall AR experience	0.80	4.09	0.72		

I was contented with the overall AR experience	0.86	3.82	0.78			
I was delighted with the overall AR experience	0.85	3.82	0.81			
<b>Visitor Engagement</b> (Criado & Such, 2011; Isiaq & Jamil, 2017)				0.86	0.68	0.86
This experience has motivated me to find out more about the history of science in Manchester	0.83	3.51	1.04			
This experience has motivated me to find out more about science research in Manchester	0.87	3.51	1.06			
This experience has motivated me to participate in science festival activities in Manchester	0.76	3.35	1.12			

360 Table 3. Reliability and Cross-Loadings

	1	2	3	4	5	6
1 Esthetics						
2 Education	0.67					
3 Entertainment	0.71	0.61				
4 Escapism	0.60	0.36	0.40			
5 Memory	0.60	0.54	0.49	0.42		
6 Satisfaction	0.61	0.63	0.60	0.37	0.56	
7 Visitor Engagement	0.55	0.53	0.42	0.36	0.45	0.58

361 All correlations are significant at  $p < .001$ 

362 Table 4. Correlation and discriminant validity

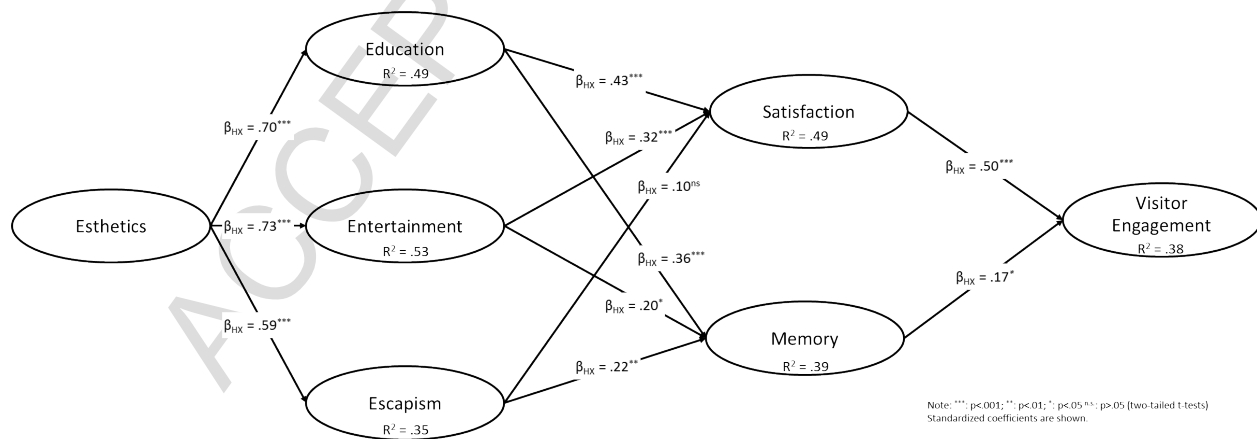
363

## 364 5.3 Main Effects

365 Mplus 7.1 (Muthen & Muthen, 2012) was used to model the structural relationships proposed in  
 366 the hypotheses (see Figure 5). We applied the MLR estimator to estimate the model, a maximum  
 367 likelihood estimator with a robust error term. In survey research, common assumptions for  
 368 maximum likelihood estimators, such as multivariate Gaussian distribution or sample size, are not  
 369 given. Recent research shows that MLR outperforms traditional ML-estimators in these realistic  
 370 scenarios. Global fit measures of this main effects model indicate a good model fit ( $\chi^2=369.7$ ;  
 371  $df=218$ ; CFI=.95; TLI=.94; RMSEA=.056; SRMR=.058).

372

373



374

375

376 Fig. 5. Structural Equation Model

377



378  
 379 Results indicate significant effects from esthetics on education ( $\beta_{H1a}=.70$ ;  $p<.001$ ), entertainment  
 380 ( $\beta_{H1b}=.73$ ;  $p<.001$ ), and escapism ( $\beta_{H1c}=.59$ ;  $p<.001$ ). Thus, results support H1a, H1b, and H1c.  
 381 Next, we investigate the effects from the three endogenous experience economy variables on  
 382 satisfaction and memory. Results show significant effects for education ( $\beta_{H2a}=.42$ ;  $p<.001$ ) and  
 383 entertainment ( $\beta_{H2b}=.32$ ;  $p<.001$ ) on satisfaction, supporting H2a and H2b. Results for escapism  
 384 are in the proposed direction, ( $\beta_{H2c}=.10$ ;  $p=.14$ ), but do not reach significance, rejecting H2c. These  
 385 variables together explain 49.4% of satisfaction's variance. Memory, in contrast, is influenced by  
 386 education ( $\beta_{H3a}=.36$ ;  $p<.001$ ), entertainment ( $\beta_{H3b}=.20$ ;  $p=.02$ ), and escapism ( $\beta_{H3c}=.22$ ;  $p<.01$ )  
 387 supporting H3a, H3b, and H3c. These variables together explain 38.7% of memory's variance.  
 388 Finally, we inspect the constructs that are hypothesized to relate to public engagement. In support  
 389 of H4 and H5, results show significant effects for satisfaction ( $\beta_{H4}=.50$ ;  $p<.001$ ) and a partially  
 390 effect for memory ( $\beta_{H5}=.17$ ;  $p=.06$ ). Both constructs explain 37.7% in consumers' variation  
 391 regarding public engagement. Following recent recommendations in mediation research, we also  
 392 assessed the indirect effects. Therefore, we ran 10,000 bootstrap resamples and estimated the 95%  
 393 confidence intervals. A mediation effect is established if its confidence interval an indirect effect  
 394 does not include zero. Mediation was established for all indirect effects, except the  
 395 esthetics→escapism→satisfaction link, where also H2c did not receive empirical support. Details  
 396 are presented in Appendix 2.

## 397 398 6. Discussion, Implications, and Limitations

399 The aim of this study was to examine how visitor experience using AR affect visitors' satisfaction,  
 400 memory, and eventually visitors' engagement with science experience in the context of science  
 401 festivals. The results showed that esthetics are a strong predictor of education, entertainment, and  
 402 escapism within the AR experience in the science festival context. Consequently, it can be argued  
 403 that AR experience design and the harmonious integration of content and features is critical in  
 404 order to provide visitors with an educational, enjoyable, and escaping experience. Theoretically,  
 405 this study shows that the experience economy in the context of AR applications and science  
 406 festivals does not consist of four independent dimensions. In comparison to previous studies (e.g.  
 407 Jung et al., 2016; Manthiou et al., 2014) that tested the experience dimensions on one-level (as  
 408 presented in Table 1) and, thereby, often failed to find all four experience dimensions significant,  
 409 the present study supported all four dimensions using a mediating structure. In fact, this study has  
 410 shown that esthetical design of the application drives the remaining experience economy  
 411 constructs, which is supported by previous research on the importance of AR user requirements in  
 412 terms of application design (tom Dieck et al., 2016).

413  
 414 In addition, this study supports that the remaining three realms of the experience economy  
 415 influence visitors' satisfaction and positive memories of the AR science festival experience. This  
 416 ultimately influences visitors' engagement with science. Considering the importance for cities to  
 417 engage visitors with their heritage, the use of AR was found to not only bring history to life, but  
 418 also actively engages visitors and facilitates the gathering of new information. This is especially  
 419 important considering that science festivals aim to engage a broader audience, and AR can be used  
 420 in order create awareness and public engagement among so far neglected audiences (Bultitude,  
 421 2014). For the visitors industry, AR provides an opportunity to create awareness of points of  
 422 interests that cities and destinations have to offer. In the future, applications do not need to be  
 423 limited to a science or history tour, but destinations could offer personalized tours to tourists based

424 on their interests and preferences. This shows the clear potential for destinations to utilize AR to  
425 create unique selling points and memorable experiences, a key aim of Pine and Gilmore's (1998)  
426 framework.

427

### 428 6.1 Theoretical Contributions

429 This study has several theoretical contributions. The most important contributions are (1) a novel  
430 conceptualization of experience economy, and (2) the identification of two routes how satisfaction  
431 and memory compete in driving a third crucial variable in AR research: visitor engagement. We  
432 will discuss each of these contributions in detail below.

433

434 Experience economy, in its initial article (Pine & Gilmore, 1998), was discussed as a new era of  
435 consumption, replacing the age of functional benefits with experiences derived through  
436 consumption. Research from various disciplines realized the potential of this new paradigm and  
437 applied it in various settings. Through a review of literature, we identified numerous studies that  
438 applied the concept of experience economy in related contexts (e.g. Hosany & Witham, 2009; Jung  
439 et al., 2016). This review identified some inconsistencies, such as different conceptualizations,  
440 inconsistent findings, and strong correlations between the four factors. Supplementing these  
441 observations with technology and media research and incorporating basic human decision making  
442 led to a novel conceptualization: The results support our theory that the elements of experience  
443 economy – esthetics, education, entertainment, and escapism – are not 'on the same level'. In  
444 contrast, our findings suggest that AR experiences start with an assessment of the esthetics. The  
445 assessment of the esthetics determines the magnitude of the remaining elements, namely education,  
446 entertainment, and escapism. This is an important contribution for several reasons. For example,  
447 as shown in Table 1, most prior experience economy studies concluded that only selected variables  
448 matter. In this study, we show that all four experience economy constructs are relevant within the  
449 AR context. However, the effect of esthetics is indirect, as mediated by education, entertainment,  
450 and escapism. Prior research that modelled these factors on the same conceptual level did not find  
451 these effects and, in addition, might have struggled with methodological issues such as  
452 multicollinearity. Thus, by drawing on prior research on decision making in related context, this  
453 study extends the understanding of experience economy specifically in the context of AR, and  
454 likely also in other domains.

455

456 The second major contribution is grounded in the evaluation of the experience itself. While prior  
457 research has typically relied on satisfaction or behavioral intentions, this study provides a more  
458 nuanced assessment. In particular, we incorporated satisfaction and memory as direct  
459 consequences of the experience and as mediators in the experience-behavior relationships. Only  
460 few studies (e.g. Oh et al., 2007) have looked at the connection of experience economy to  
461 satisfaction and memory, however, without the dependent variable of visitor engagement.  
462 Considering the importance of engaging visitors in order to create memorable experiences, this is  
463 an important dimension that has not been explored within previous experience economy studies.  
464 Thus, this can be considered the main contribution to knowledge. Whilst all the experience  
465 economy constructs showed at least weak effects on both constructs, we identified a series of  
466 differences. For example, education showed the strongest effect, which is probably due to visitors'  
467 expectations to learn something. This indicates that visitors who are actively engaged in science  
468 festival activities gained new skills and knowledge (Oh et al., 2007). On the contrary, escapism  
469 showed the weakest effect, which may be due to the fact that current AR application contains more



470 passive delivery of content (e.g. video clips of scientists). This implies that creation of interactive  
471 AR contents for active participation of visitors as well as immersive experience are critical for  
472 visitor engagement.

473

## 474 6.2 Practical Implications

475 Many practical implications were identified from this study. First, esthetics is an important  
476 experience economy construct for AR experiences during science festivals, which clearly shows  
477 the importance of interface within AR applications for festival managers and application  
478 developers alike. Second, education, entertainment, and escapism experiences via AR have a  
479 positive impact on satisfaction and memory. Consequently, AR experiences will bring more  
480 memorable and satisfied visitor experience during science festivals. Therefore, festival organizers  
481 and applications developers should design more informative, enjoyable, and immersive AR  
482 experiences for science festival attendees. Third, science festival attendees will engage more when  
483 they have AR-enhanced experiences that tell the hidden stories of science and scientists attached  
484 to physical buildings, statues, and plaques. It is proven that AR experiences with place attachment  
485 is an effective way of encouraging visitor engagement with science festivals. Finally, AR is a  
486 useful tool to improve memory, which is particularly important for science festival attendees'  
487 engagement; thus, AR applications should contain visually attractive and interesting hidden stories  
488 for memorable experiences, which will have a higher impact on the success of science festivals.  
489 Overall, the present study focused on science festivals however, findings are important for  
490 managers from various disciplines that are involved in creating immersive, enjoyable and  
491 educational experiences through immersive technologies. Manthiou et al. (2014) for instance  
492 suggested that the four realms should act as guidelines as to how festivals should be organised and  
493 where priorities need to be placed. From this, our findings suggest that the design of applications  
494 acts as a stepping stone for creating entertaining, educational and immersive experiences that  
495 ultimately lead to the engagement of audiences. Therefore, previous examples from museums,  
496 schools and art galleries have shown the benefits of AR and our findings support the strength of  
497 this new and innovative technology in order to create memorable and satisfying experiences and  
498 support engagement. In fact, within the museum context, Lee et al. (2015) supported that the initial  
499 impression of an application with regards to its esthetical features leads to hedonic motivations  
500 and positive intentions to use the application in the future. The present study supports this finding  
501 and emphasises on application design. In order to do so, app developers are advised to follow the  
502 principles of the experience economy to ensure that content and functionalities result in the desired  
503 outcome. A study on AR requirements within the tourism context supported the importance of the  
504 four realms as tom Dieck et al. (2016) found that learning, hedonic features, comfort and  
505 application quality are key requirements for AR applications. In addition, a recent study from a  
506 festival found that the escaping from reality is one of the key advantages of using virtual  
507 applications (Jung et al., 2017). Consequently, the four realms of the experience economy are  
508 extremely important within the tourism context and science festival organisers are advised to  
509 incorporate these characteristics into festival activities to ensure visitor engagement.

510

## 511 6.3 Limitations and Future Research

512 As with every study, there are several limitations that need to be addressed. The first limitation  
513 relates to the data collection in only one city using one AR application, as it limits generalisation.  
514 Therefore, more research should be conducted on AR science festival experiences in different  
515 destinations. In addition, the present study was limited to the four realms of the experience

516 economy, and further factors affecting visitors' satisfaction and memory of AR experiences and  
 517 intention to engage with science should be explored and tested. Therefore, a mixed-method study  
 518 should help to fully explore and validate determinants of visitor engagement. This is expected to  
 519 enhance the explanatory power and extend existing theories. Finally, as discussed in Table 1, most  
 520 prior research (and this study) has studied net-effects of the four experience economy constructs.  
 521 [During the last years, scholars \(e.g., Woodside, 2013; Kourouthanassis et al., 2017; Pappas et al.,](#)  
 522 [2017; Woodside et al., 2015\) have taken a different approach and studies suggest configuration](#)  
 523 [analyses as a potential alternative to the standard regression-based net effects models \(e.g.](#)  
 524 [regression or SEM\).](#) The four constructs of experience economy could be combined with other  
 525 factors (e.g., personality, culture and so forth) to identify complex and asymmetric relations  
 526 between these constructs to explain desired outcomes<sup>1</sup>. This might lead to higher explanatory  
 527 power and deeper insights into the mechanisms that drive consumer reaction in AR. In addition,  
 528 the present study focused on visitor engagement from the tourists' point-of-view, and further  
 529 research could explore the differences between domestic and international tourists with regards to  
 530 which factors influence the engagement with science. For destination marketing organizations, this  
 531 would provide important implications for AR application design and acceptance among diverse  
 532 types of users.

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710 Appendix  
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 712 Constructs and definitions  
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Constructs	Definition
Esthetics	<i>"The beauty that can be expressed through the elements such as color, photographs, font style, and layout" (Lee et al., 2015, p. 481)</i>
Education	<i>The absorption of "events unfolding before [a tourist] at a destination, while actively participating through interactive engagement of the mind" (Oh et al., 2007, p. 121)</i>
Entertainment	<i>Entertainment is "an activity that provides amusement and pleasure" (Benny, 2005, p. 7)</i>
Escapism	<i>The escape "of [tourists] regular environments to suspend the power of norms and values that govern their ordinary lives or to think about their lives and societies from a different perspective" (Oh et al., 2007, p. 122)</i>
Memories	<i>The "mental revival of conscious experience" (Conway et al., 2013, p. 31)</i>
Satisfaction	<i>The "psychological state experienced by the consumer when confirmed or disconfirmed expectations exist with respect to a specific service transaction or experience" (Palmer, 2010, p. 199)</i>
Visitor engagement	<i>Visitor engagement is "a state of being involved with and committed to a specific market offering" (Taheri et al., 2014, p. 322)</i>

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716 Appendix 2: Indirect Effects  
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Dependent Variable: Memory	95% CI <sub>low</sub>	$\beta$	95% CI <sub>high</sub>	Mediation?
<b>Total Indirect (sum)</b>	<b>0.491</b>	<b>0.640</b>	<b>0.795</b>	✓
Esthetics - Education - Memory	0.163	0.304	0.469	✓
Esthetics - Entertainment - Memory	0.048	0.180	0.329	✓
Esthetics - Escapist - Memory	0.060	0.156	0.259	✓
Dependent Variable: Satisfaction	95% CI <sub>low</sub>	$\beta$	95% CI <sub>high</sub>	Mediation?
<b>Total Indirect (sum)</b>	<b>0.335</b>	<b>0.470</b>	<b>0.617</b>	✓
Esthetics - Education - Satisfaction	0.143	0.237	0.363	✓
Esthetics - Entertainment - Satisfaction	0.094	0.188	0.295	✓
Esthetics - Escapist - Satisfaction	-0.004	0.045	0.098	×

718 Note: coefficients are unstandardized effects. ML estimator and bootstrapping (10,000 resamples) applied.



## Highlights

- Using the experience economy, the effect of AR on visitor engagement was explored
- Data were gathered from 220 visitors to Manchester during Science Festivals
- Esthetics was found to influence the remaining three experience economy constructs
- Satisfaction and memory mediate the path of experience economy on engagement