

1 **Determining Visitor Engagement through Augmented Reality at Science Festivals: An**
2 **Experience Economy Perspective**

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44 **Determining Visitor Engagement through Augmented Reality at Science Festivals: An**
45 **Experience Economy Perspective**

46
47 Abstract

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

61
62 **Keywords:** Augmented reality, science festivals, visitor engagement, experience economy,
63 satisfaction, memory

64
65 1. Introduction

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

89

90 Recently, research started to use the framework of the Experience Economy by Pine and Gilmore
91 (1998) as a theoretical foundation to explore the effects of AR (Jung et al., 2016; Neuburger &
92 Egger, 2017). It includes the four realms of experience, educational, esthetics, escapist and
93 entertainment. This research direction is very valuable within the context of visitor economy
94 considering the importance of enhancing the visitor experience through various forms of
95 interaction in order to increase or sustain tourist numbers, enhance the level of engagement, and
96 generate positive word-of-mouth to ensure future sustainability. Pine and Gilmore's Experience
97 Economy model is considered to be the predominant framework within the subject area of visitor
98 experiences (Jung et al., 2016). Rather than simply providing products and services, Pine and
99 Gilmore (1998) emphasized the importance of staging experiences. Within the service-driven
100 tourism domain, many scholars have supported the importance of tourist participation for the co-
101 creation of value (Sorensen & Jensen, 2015).

102

103 Although numerous scholars (e.g., Manthiou et al., 2014; Mehmetoglu and Engen, 2011; Oh et al.,
104 2007) applied the Experience economy framework in other tourism and hospitality contexts,
105 several limitations remain. First, prior research conceptualized the four dimensions as independent
106 constructs or as a higher order constructs. In this study, we provide arguments for a process view.
107 In particular, we argue that "the first impression matters" – that esthetics are the source of
108 experience, resulting in an increase in educational, escapist and entertainment. Second, prior
109 research has mostly applied experience economy to explain established constructs, such as loyalty
110 (e.g. Manthiou et al.; 2014). This study complements prior research with a novel and managerially
111 highly target construct: Visitor engagement. Finally, despite the general consensus that experience
112 economy provides numerous advantages to media and tourism research, and scholars agree that
113 science festivals are an important subject to study, empirical applications remain of experience
114 economy remain scarce.

115

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

126

127 2. Theoretical Background

128 2.1 Augmented Reality and Visitor Experience

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

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

152 153 2.2 Experience Economy

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

161
162 The initial idea of the experience economy proposed four realms of consumer experiences based
163 on two dimensions: involvement, ranging from passive to active participation of the consumer,
164 and the desire, ranging from absorption to immersion, within which a consumer engages with a
165 consumption object. The experience economy suggests that there are four realms of an experience,
166 as displayed in Figure 1, which can be classified by a spectrum of connection (immersion and
167 absorption) along the vertical, and a spectrum of participation (active and passive) along the
168 horizontal line of the model (Pine & Gilmore, 1998). According to Quadri-Felitti and Fiore (2013,
169 p. 48), “active participation is where customers personally affect the performance or event, and
170 passive participation is where customers do not directly affect or influence the performance. In
171 addition, immersion is described as becoming physically or virtually enveloped by the event [...] whereas absorption involves engaging the consumer’s mind”.

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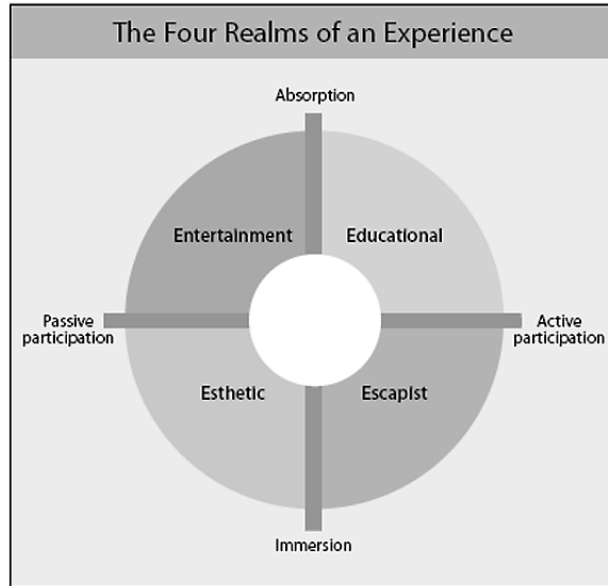


Fig. 1. Experience Economy (Pine & Gilmore, 1998)

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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 |

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|---------------------------|---|--------------------------|----------------------------|---|--|
| 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 |

193 Table 1. Summary of previous studies

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195 While the flexibility is a major strength of the experience economy framework, it is also associated
196 with a number of concerns, ranging from criticism on the conceptualization to lack of measurement
197 challenges. While addressing the measurement challenges of each of the four experiences have
198 been subject to numerous studies (e.g. Oh et al., 2007; Hosany & Witham, 2009), the overall
199 conceptualization provides some unanswered questions. For example, whereas Pine and Gilmore
200 (1998) argued that the interaction of two dimensions, involvement and desire, are sufficient to
201 generate four types of experience, other studies, especially in the tourism context, have found that
202 each of the four experiences should either serve as individual dimensions, or be treated as a higher-
203 order construct (e.g. Loureiro, 2014). However, as shown in Table 1, studies that compared the
204 effects of each of the four constructs on target variables often concluded that only a few of them
205 matter. An inspection of the correlations between the factors indicates meaningful correlations
206 between all four variables, indicating that – contrary to Pine and Gilmore (1998)'s framework –
207 the four constructs are not independent of each other. This study aims to extend prior research on
208 experience economy in several ways.

209

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

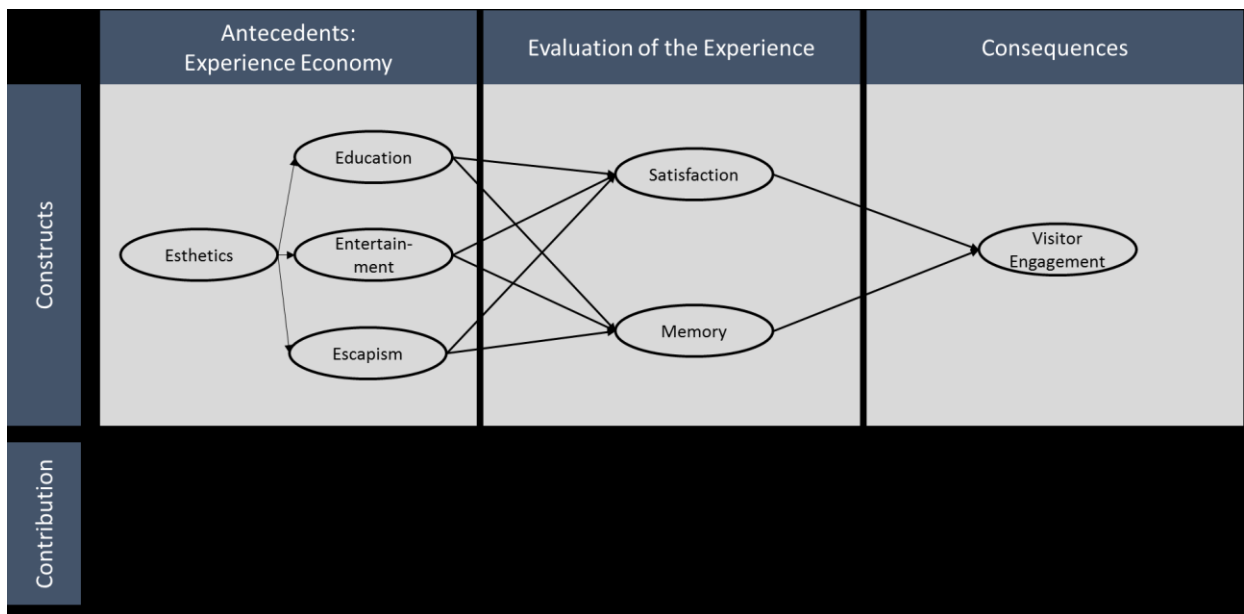
215 applying each construct on one level. In addition, none of the studies incorporated the effects of
 216 the experience economy constructs on satisfaction, memory and ultimately visitor engagement.

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

225
 226 **3. Proposed Model**

227 Figure 2 shows the basic theoretical framework of this study. First, we propose that visitors’ actual
 228 use of an AR device triggers the constructs of the experience economy framework, whereas – in
 229 contrast to prior research (see Table 1) – we provide a more nuanced relationship between the four
 230 constructs. Second, we propose that experience economy constructs determine visitors’ overall
 231 evaluation of the on-site AR experience. In particular, we propose that the experience economy
 232 serves how much people enjoyed using the AR experience (satisfaction), but also to what extent
 233 the experience stays in their mind (memory). Third, the model proposes that satisfaction and
 234 memory both impact visitor engagement, a crucial, yet under-researched, construct in tourism
 235 research.

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 239 Fig. 2. Proposed Model

240
 241 **3.1 Experience Economy**

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

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

248 In a related context, Pallud and Straub (2014) show that aesthetics represent the most important
249 criteria for interface development, which ultimately dictates whether visitors accept or reject latest
250 technologies. In particular, especially when technologies become more immersive, both Jung et al
251 (2016) and Lee et al. (2015) argue that interface design becomes even more relevant than in less
252 immersive contexts. Tourism scholars, such as Hosany and Witham (2009) or Mykletun & Rumba
253 (2014) even argue that esthetics are among the most important drivers within the experience
254 economy. Likewise, Jung et al. (2018)'s cross-cultural study on AR concludes that esthetics are
255 particularly relevant since it can compensate for technological limitations of many current AR
256 devices. Consequently, this means that if esthetics of an experience are low, the educational,
257 entertainment, and escapism experiences are likely to suffer. On the other hand, once users are
258 exposed to a favourable esthetics experience, this should translate to higher levels of education
259 (H1a), entertainment (H1b) and escapism (H1c) dimension. This is a different conceptualization
260 of most prior studies (see table 1). In particular, most prior studies implicitly assume, for example,
261 that users rate the escapism value of apps independently of their esthetic experience. Simplified
262 speaking, this would imply that the escapism experience would not suffer if an app was poorly
263 designed (Jung et al., 2018). This assumption would also imply that poorly designed apps provide
264 the same educational and entertainment experience than well-designed ones, assumptions that
265 prior theory and reported correlations might question. Thus, we propose esthetics as a determinant
266 of the remaining three experience constructs and, thus, the following is hypothesized:

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268 H1a: Esthetics has a positive effect on education.

269 H1b: Esthetics has a positive effect on entertainment.

270 H1c: Esthetics has a positive effect on escapism.

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272 3.2 Experience Economy and Satisfaction

273 According to Srivastava and Kaul (2014, p. 1028), satisfaction can be defined as “consumer
274 judgment that a product or service provides a pleasurable level consumption-related fulfilment”,
275 which has long been discussed as an important determinant of behavioral intentions within
276 technology adoption research (e.g. tom Dieck et al., 2017). According to Mehmetoglu and Engen
277 (2011), experiences allow people to draw upon the events to paint a picture of their lives. They
278 allow for an evaluation of an individual's perception of his or her self-image, which is the
279 aggregation of his or her lifetime experiences. Following this logic, Mehmetoglu and Engen (2011)
280 argued that individual experiences are highly important for consumers' views and satisfaction of
281 products or services. Furthermore, as part of the experience economy, there has been sufficient
282 evidence of strong impacts of the realms of experience economy on satisfaction. For instance, the
283 effect of education and entertainment onto tourist satisfaction within the film festival context was
284 supported by Park et al. (2010), and Quadri-Felitti and Fiore (2013) confirmed that education
285 strongly affects satisfaction within the tourism context. Consequently, this study proposed that:

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287 H2a: Education has a positive effect on satisfaction.

288 H2b: Entertainment has a positive effect on satisfaction.

289 H2c: Escapism has a positive effect on satisfaction.

290

291 3.3 Experience Economy and Memory

292 Studies have long acknowledged the importance of experiencing events and the consequent
293 creation of memories (Pine & Gilmore, 1998). In fact, das Gupta et al. (2016, p. 1278) revealed
294 “for many consumer-intensive (B2C) services, delivering memorable customer experiences is a
295 source of competitive advantage”. According to Manthiou et al. (2014), an experience involves
296 the input of information into the sensory system of an individual’s brain. Consequently, a memory
297 is what remains of an event after the sensory experience occurred, making it an integral part of any
298 experience framework.
299

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

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312 H3a: Education has a positive effect on memory.

313 H3b: Entertainment has a positive effect on memory.

314 H3c: Escapism has a positive effect on memory.
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316 3.4 Satisfaction, Memory, and Visitor Engagement

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

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

333 H5: Memory has a positive effect on visitor engagement.
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335 4. Methods

336 4.1 Study context

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

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4.2 Data Collection

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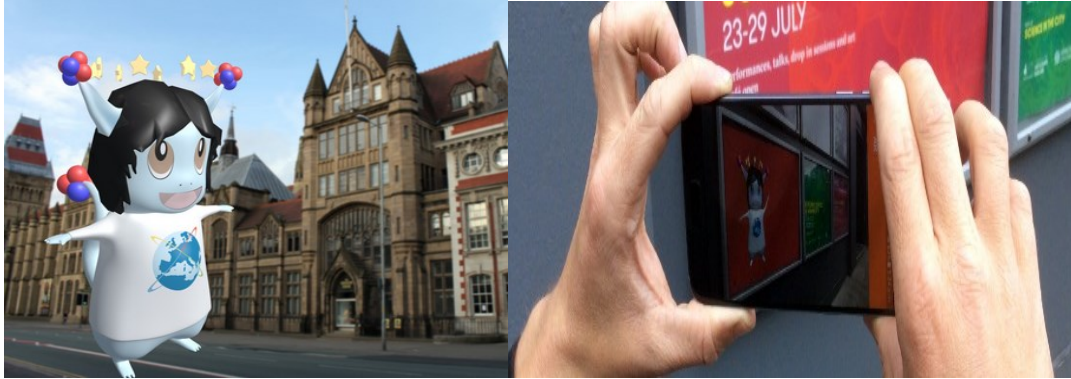


Fig. 4. Animation within AR application

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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 | % |
|-------------------------|-----|------|--------------------|-----|------|
| Gender | | | Income | | |
| Male | 124 | 56.4 | Less than £20,000 | 114 | 51.8 |
| Female | 96 | 43.6 | £20,000-£40,000 | 66 | 30.0 |
| Age | | | £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 | Occupation | | |
| 55-64 | 4 | 1.8 | Full-time employed | 74 | 33.6 |
| 65+ | 3 | 1.4 | Part-time employed | 15 | 6.8 |
| Education | | | 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 | | | |
| | | | Total | 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

392 the χ^2 -value of 350.2 (df=209) was significant ($p < .001$), the χ^2/df ratio of 1.7 was lower than 4 and,
 393 thus, acceptable. In addition, the model fit (CFI=.95; TLI=.94; RMSEA=.06; SRMR=.05) reflects
 394 absence of substantial approximation errors and shows no substantial differences between
 395 observed and predicted correlation matrices. Then, we, assessed the psychometric characteristics
 396 on a construct level. As shown in Table 3, all factor loadings are significant ($p < .001$) and above .70.
 397 In addition, Cronbach's alpha (α), Composite Reliability (CR), and Average Variance Extracted
 398 (AVE) exceeded the recommended threshold of .7, .7, and .5, respectively. We assessed
 399 discriminant validity using the Fornell and Larcker (1981) procedure. Evidence of discriminant
 400 validity exists in the study, as AVE values all are above the squared construct correlations (Hair
 401 et al., 2006) (see Table 4).
 402

| Constructs and Items | Mean | SD | CR | AVE | α |
|---|------|------|------|------|----------|
| Esthetics (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 | | |
| Education (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 | | |
| Entertainment (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 | | |
| Escapism (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 | | |
| Memories (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 | | |
| Satisfaction (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 | | | |
| Visitor Engagement (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 | | | |

403 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 |

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

405 Table 4. Correlation and discriminant validity

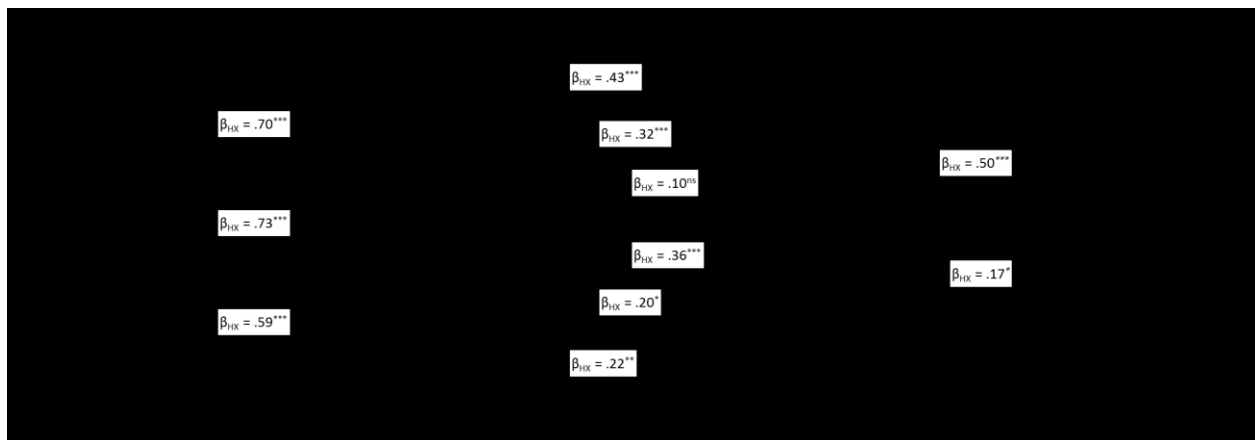
406

407 5.3 Main Effects

408 Mplus 7.1 (Muthen & Muthen, 2012) was used to model the structural relationships proposed in
 409 the hypotheses (see Figure 5). We applied the MLR estimator to estimate the model, a maximum
 410 likelihood estimator with a robust error term. In survey research, common assumptions for
 411 maximum likelihood estimators, such as multivariate Gaussian distribution or sample size, are not
 412 given. Recent research shows that MLR outperforms traditional ML-estimators in these realistic
 413 scenarios. Global fit measures of this main effects model indicate a good model fit ($\chi^2=369.7$;
 414 $df=218$; CFI=.95; TLI=.94; RMSEA=.056; SRMR=.058).

415

416



417

418

419 Fig. 5. Structural Equation Model

420

421
422 Results indicate significant effects from esthetics on education ($\beta_{H1a}=.70$; $p<.001$), entertainment
423 ($\beta_{H1b}=.73$; $p<.001$), and escapism ($\beta_{H1c}=.59$; $p<.001$). Thus, results support H1a, H1b, and H1c.
424 Next, we investigate the effects from the three endogenous experience economy variables on
425 satisfaction and memory. Results show significant effects for education ($\beta_{H2a}=.42$; $p<.001$) and
426 entertainment ($\beta_{H2b}=.32$; $p<.001$) on satisfaction, supporting H2a and H2b. Results for escapism
427 are in the proposed direction, ($\beta_{H2c}=.10$; $p=.14$), but do not reach significance, rejecting H2c. These
428 variables together explain 49.4% of satisfaction's variance. Memory, in contrast, is influenced by
429 education ($\beta_{H3a}=.36$; $p<.001$), entertainment ($\beta_{H3b}=.20$; $p=.02$), and escapism ($\beta_{H3c}=.22$; $p<.01$)
430 supporting H3a, H3b, and H3c. These variables together explain 38.7% of memory's variance.
431 Finally, we inspect the constructs that are hypothesized to relate to public engagement. In support
432 of H4 and H5, results show significant effects for satisfaction ($\beta_{H4}=.50$; $p<.001$) and a partially
433 effect for memory ($\beta_{H5}=.17$; $p=.06$). Both constructs explain 37.7% in consumers' variation
434 regarding public engagement. Following recent recommendations in mediation research, we also
435 assessed the indirect effects. Therefore, we ran 10,000 bootstrap resamples and estimated the 95%
436 confidence intervals. A mediation effect is established if its confidence interval an indirect effect
437 does not include zero. Mediation was established for all indirect effects, except the
438 esthetics→escapism→satisfaction link, where also H2c did not receive empirical support. Details
439 are presented in Appendix 2.

440 441 6. Discussion, Implications, and Limitations

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

456
457 In addition, this study supports that the remaining three realms of the experience economy
458 influence visitors' satisfaction and positive memories of the AR science festival experience. This
459 ultimately influences visitors' engagement with science. Considering the importance for cities to
460 engage visitors with their heritage, the use of AR was found to not only bring history to life, but
461 also actively engages visitors and facilitates the gathering of new information. This is especially
462 important considering that science festivals aim to engage a broader audience, and AR can be used
463 in order create awareness and public engagement among so far neglected audiences (Bultitude,
464 2014). For the visitors industry, AR provides an opportunity to create awareness of points of
465 interests that cities and destinations have to offer. In the future, applications do not need to be
466 limited to a science or history tour, but destinations could offer personalized tours to tourists based

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

470 471 6.1 Theoretical Contributions

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

476
477 Experience economy, in its initial article (Pine & Gilmore, 1998), was discussed as a new era of
478 consumption, replacing the age of functional benefits with experiences derived through
479 consumption. Research from various disciplines realized the potential of this new paradigm and
480 applied it in various settings. Through a review of literature, we identified numerous studies that
481 applied the concept of experience economy in related contexts (e.g. Hosany & Witham, 2009; Jung
482 et al., 2016). This review identified some inconsistencies, such as different conceptualizations,
483 inconsistent findings, and strong correlations between the four factors. Supplementing these
484 observations with technology and media research and incorporating basic human decision making
485 led to a novel conceptualization: The results support our theory that the elements of experience
486 economy – esthetics, education, entertainment, and escapism – are not 'on the same level'. In
487 contrast, our findings suggest that AR experiences start with an assessment of the esthetics. The
488 assessment of the esthetics determines the magnitude of the remaining elements, namely
489 education, entertainment, and escapism. This is an important contribution for several reasons. For
490 example, as shown in Table 1, most prior experience economy studies concluded that only selected
491 variables matter. In this study, we show that all four experience economy constructs are relevant
492 within the AR context. However, the effect of esthetics is indirect, as mediated by education,
493 entertainment, and escapism. Prior research that modelled these factors on the same conceptual
494 level did not find these effects and, in addition, might have struggled with methodological issues
495 such as multicollinearity. Thus, by drawing on prior research on decision making in related
496 context, this study extends the understanding of experience economy specifically in the context of
497 AR, and likely also in other domains.

498
499 The second major contribution is grounded in the evaluation of the experience itself. While prior
500 research has typically relied on satisfaction or behavioral intentions, this study provides a more
501 nuanced assessment. In particular, we incorporated satisfaction and memory as direct
502 consequences of the experience and as mediators in the experience-behavior relationships. Only
503 few studies (e.g. Oh et al., 2007) have looked at the connection of experience economy to
504 satisfaction and memory, however, without the dependent variable of visitor engagement.
505 Considering the importance of engaging visitors in order to create memorable experiences, this is
506 an important dimension that has not been explored within previous experience economy studies.
507 Thus, this can be considered the main contribution to knowledge. Whilst all the experience
508 economy constructs showed at least weak effects on both constructs, we identified a series of
509 differences. For example, education showed the strongest effect, which is probably due to visitors'
510 expectations to learn something. This indicates that visitors who are actively engaged in science
511 festival activities gained new skills and knowledge (Oh et al., 2007). On the contrary, escapism
512 showed the weakest effect, which may be due to the fact that current AR application contains more

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

516

517 6.2 Practical Implications

518 Many practical implications were identified from this study. First, esthetics is an important
519 experience economy construct for AR experiences during science festivals, which clearly shows
520 the importance of interface within AR applications for festival managers and application
521 developers alike. Second, education, entertainment, and escapism experiences via AR have a
522 positive impact on satisfaction and memory. Consequently, AR experiences will bring more
523 memorable and satisfied visitor experience during science festivals. Therefore, festival organizers
524 and applications developers should design more informative, enjoyable, and immersive AR
525 experiences for science festival attendees. Third, science festival attendees will engage more when
526 they have AR-enhanced experiences that tell the hidden stories of science and scientists attached
527 to physical buildings, statues, and plaques. It is proven that AR experiences with place attachment
528 is an effective way of encouraging visitor engagement with science festivals. Finally, AR is a
529 useful tool to improve memory, which is particularly important for science festival attendees'
530 engagement; thus, AR applications should contain visually attractive and interesting hidden stories
531 for memorable experiences, which will have a higher impact on the success of science festivals.
532 Overall, the present study focused on science festivals however, findings are important for
533 managers from various disciplines that are involved in creating immersive, enjoyable and
534 educational experiences through immersive technologies. Manthiou et al. (2014) for instance
535 suggested that the four realms should act as guidelines as to how festivals should be organised and
536 where priorities need to be placed. From this, our findings suggest that the design of applications
537 acts as a stepping stone for creating entertaining, educational and immersive experiences that
538 ultimately lead to the engagement of audiences. Therefore, previous examples from museums,
539 schools and art galleries have shown the benefits of AR and our findings support the strength of
540 this new and innovative technology in order to create memorable and satisfying experiences and
541 support engagement. In fact, within the museum context, Lee et al. (2015) supported that the initial
542 impression of an application with regards to its esthetical features leads to hedonic motivations
543 and positive intentions to use the application in the future. The present study supports this finding
544 and emphasises on application design. In order to do so, app developers are advised to follow the
545 principles of the experience economy to ensure that content and functionalities result in the desired
546 outcome. A study on AR requirements within the tourism context supported the importance of the
547 four realms as tom Dieck et al. (2016) found that learning, hedonic features, comfort and
548 application quality are key requirements for AR applications. In addition, a recent study from a
549 festival found that the escaping from reality is one of the key advantages of using virtual
550 applications (Jung et al., 2017). Consequently, the four realms of the experience economy are
551 extremely important within the tourism context and science festival organisers are advised to
552 incorporate these characteristics into festival activities to ensure visitor engagement.

553

554 6.3 Limitations and Future Research

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

559 economy, and further factors affecting visitors' satisfaction and memory of AR experiences and
560 intention to engage with science should be explored and tested. Therefore, a mixed-method study
561 should help to fully explore and validate determinants of visitor engagement. This is expected to
562 enhance the explanatory power and extend existing theories. Finally, as discussed in Table 1, most
563 prior research (and this study) has studied net-effects of the four experience economy constructs.
564 During the last years, scholars (e.g., Woodside, 2016; Kourouthanassis et al., 2017; Pappas et al.,
565 2017; Woodside et al., 2015) have taken a different approach and studies suggest configuration
566 analyses as a potential alternative to the standard regression-based net effects models (e.g.
567 regression or SEM). The four constructs of experience economy could be combined with other
568 factors (e.g., personality, culture and so forth) to identify complex and asymmetric relations
569 between these constructs to explain desired outcomes¹. This might lead to higher explanatory
570 power and deeper insights into the mechanisms that drive consumer reaction in AR. In addition,
571 the present study focused on visitor engagement from the tourists' point-of-view, and further
572 research could explore the differences between domestic and international tourists with regards to
573 which factors influence the engagement with science. For destination marketing organizations, this
574 would provide important implications for AR application design and acceptance among diverse
575 types of users.

576
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744 Appendix
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746 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, 2015, 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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750 Appendix 2: Indirect Effects
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| Dependent Variable: Memory | 95% CI _{low} | β | 95% CI _{high} | Mediation? |
|------------------------------------|-----------------------|--------------|------------------------|------------|
| Total Indirect (sum) | 0.491 | 0.640 | 0.795 | ✓ |
| 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 _{low} | β | 95% CI _{high} | Mediation? |
|--|-----------------------|--------------|------------------------|------------|
| Total Indirect (sum) | 0.335 | 0.470 | 0.617 | ✓ |
| 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 | × |

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