

## Article

# Augmenting Museum Communication Services to Create Young Audiences

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**Abstract:** The aim of this paper is to demonstrate how museums use Augmented Reality (AR) to enhance communication services with their audiences and attract new ones. Still, there is no definite answer to how young audiences perceive the educational effects of experiencing this augmented space of communication as an immersive medium. This study is based on a survey of 400 students after they visited an AR technology-enhanced exhibition held by a local history museum. Two stimulus–response marketing scale metrics, widely used to assess TV commercials, were adapted for AR experiences and validated. The mediation analysis revealed an intervening emotional mechanism, in which the multisensory AR experience has educational effects through entertainment and empathy. An improved stimulus–response empirical model is proposed, in which AR technologies, as environmental multisensory stimuli, produce cognitive responses through emotional immersion. The findings have significance in improving how museums encode their message using AR technologies as a secondary communication medium with young audiences. By using a widely tested scale for evaluating TV commercials adapted to measure AR experiences, this study could inform museum professionals and application developers to improve AR implementation solutions as service tools for enhancing user experience.

**Keywords:** augmented reality; education; empathy; engagement; entertainment; young audiences

## 1. Introduction

Museum visitors have to be engaged with the collections through the creation of the right environment in order to enhance their understanding and appreciation [1]. For this reason, museums have to adopt techniques from relational and experiential marketing fields to improve services with their audiences. Exhibitions are one part of a museum’s tool kit through which they communicate and engage with the public [2]. In customizing and adding authenticity to the experience of heritage collections, current and future museum visitors are being targeted using the complementarity between what is traditionally referred to as the real and the emerging digital or virtual universe [3]. Placed somewhere in the middle of the so-called Real World and Virtual Reality (VR), Augmented Reality (AR) has been acknowledged as one of the innovations that could engage users when exploring heritage sites or historical events [4,5]. Relatedly, marketing specialists theorize that, in order to maximize visitors’ experiences and attract new audiences, a museum’s communication strategies and engagement activities should focus on new technologies, creative events, and edutainment [6]. Wise, adapted communication strategies will sustainably build the museum’s brand, as the branding process acts as a benefit to the function and the mission of a cultural organization [7,8]. At the same time, visitors’ experiences have to be understood from a dynamic holistic perspective [9]. Despite the theoretical foundation, there are only a limited number of empirical studies on AR implementation at cultural heritage sites [10,11]. In particular, little research has been conducted to understand the satisfaction

and intention to use or accept AR applications in museums [11]. Thus, the present study was designed to empirically explore potential directions to improve museums' communication with their audiences with the help of AR technologies.

### 1.1. Background

The plot of this research was triggered by the fact that, for the first time in Romania, a local museum introduced a new AR technology medium to their permanent exhibition in order to enhance visitors' experiences and attract young audiences. The Mureșanu Family Museum is the memorial house of a prestigious family of Brașov city, whose members played a prominent role in the cultural and political life of urban Transylvania during the 18th century and the beginning of the 19th century. In Romania, the Mureșanu family is most often related to the lyrics of the national anthem and the first Romanian political newspaper in Transylvania. The museum is organized as a family house displaying objects and documents to recreate the atmosphere of daily life both in the small context of an intellectual family home and in the wider socio-political context of the local history of Brașov city and Transylvania region. Even so, it proved not to be a major attraction for young audiences, as they are more focused on the future and less on understanding the past through "dated" artefacts. Confronted with this communication barrier in delivering their message to young audiences, the museum staff decided to use modern technologies, such as AR/VR guided tools, to come closer to their actual and potential visitors.

Accordingly, in 2017, the museum staff implemented a project in which the permanent exhibition could be experienced using either smartphones (after installing an AR application) or gear VRs. Specifically, visitors could interact with eight AR stimuli: three virtual guides (personifying three historical characters of Mureșanu family), two short picture-in-picture documentary movies (one about a ballroom dance created by a member of Mureșanu family inspired by Romanian traditional folk dances, and another about the life in the city during the interwar period as well as about a young folk traditional ceremony), and three virtual windows towards the past (Mureșenilor Street and the Brașov Council Square seen in 3D from above, and the Zeppelin flyover in 1929, seen in motion from below). The visiting experience was multisensory, implying simultaneous hearing, seeing, and touching (with limited kinaesthetic components, experienced by either moving in the museum or being exposed to movements from movies), without involving the sense of taste or smell. The effects of the museum's communication with young audiences through the AR medium was assessed by applying a survey after people had visited the exhibition.

### 1.2. From Augmented Reality to Augmented Communication

The cultural and creative industries have to create new platforms through which museum staff cultural can communicate [12]. Museum functions include educational and entertainment, and using information and communication technology to maximize these has become a recognized issue. Many scholars have envisioned that AR technology could enrich museum visitors' experiences and the museum's communication services with them. AR is away to move forward to preserve history, enhance visitor satisfaction, generate positive word-of-mouth, and attract new target markets, as well as to create a positive learning experience [13]. Additionally, AR can be a source of technological innovation for cultural tourism [14] as it can facilitate the bringing back to life of historical buildings, the reenacting of historic events, and the rendering of additional meanings to explanations [15]. As AR applications become more available, they can be used to build personal and context-aware experiences for visitors [16]. Storytelling and enhancing content are particular ways for museums to create positive experiences using AR [17], as VR storytelling challenges people's expectations of content quality [18]. Moreover, gamifying the AR experience could increase visitor engagement and satisfaction [19], as the successful implementation of gamification will contribute to other outcomes such as loyalty, relationship development, and repeated interaction [20]. Furthermore, relevant for

the present study is that AR allows the inclusion of additional content to the exhibit interactively [21], amplifying a visitor's physical or sensory reality [22].

Despite AR's popularity, scholars have not agreed upon a common definition. In a broader sense, AR technology represents "a system where a view of a live real physical environment is supplemented by computer-generated elements such as sound, video, graphic or location data" [23]. In his seminal paper, Azuma assumed in 1997 that the combination of real and virtual images is one of the defining characteristics of AR [24]. In other definitions, the main difference among AR environments lies in their ability to transcend time and space [25] which is conventionally the primary focus of a museum's communication with their visitors, as museums recreate spaces and times from the past. Taking this idea further, Manovich [26] started from the assumption that AR adds information to the user's immediate physical space and delineated the concept of augmented space. The concept means the user is not immersed in the experience but is still present in the physical space, as the AR display only adds a new layer to the present experience. Similarly, Jin [27] described how the concept of augmented museum space can be applied to educational contexts. Building on these contributions, all these notions were combined under the concept of the *augmented museum space of communication*.

There are several communication models that can be used to nuance the concept of the augmented museum space of communication: for example, the Shannon and Weaver model of communication as applied to exhibitions [28] with its updated version for AR guided tools [29], and the communications model of Knez and Wright as applied to science museums [28] with its updated version for AR guided tools [29]. In our particular case, the multiple discussions with the exhibition team helped us determine that their intention was to transmit historical knowledge (the message) to ease the understanding of the small family context from which the exhibited objects came and to stimulate the thinking about the local history of Braşov city. In brief, the aim of the museum's communication services was mainly educational and cognitive. Encoding the message was done through the selection by the curator of particular objects, texts or events to be experienced through AR technologies (the artefacts being the primary medium of communication) and through the selection of technological facilities by AR developers (the AR app and the gear VR being the secondary medium). The exhibition is the result of encoding the message, and the educational benefits result from the decoding of the message by the visitors. The survey was created by the feedback received from curators, AR developers and visitors. Therefore, the results of the survey reflect how visitors decoded the message and can help museum staff optimize the encoding of the message (selection of artefacts and development of AR apps).

### 1.3. The Museum's Communication with Young Audiences

On the one hand, new technologies can play a substantial educational role [30]. Two decades ago, Mikropoulos et al. [31] discussed the potential of virtual technologies to become learning tools by evidencing how students enjoy using VR in their learning activities and how this increases their performance. More recently, scholars evidenced that VR increases students' motivation and engagement [32] and AR enhances learning [33–36]. On the other hand, museums, with the help of new technologies, can become ideal learning environments. There are arguments that young people are more motivated and actively engaged in heritage learning when technology is involved [37]. Moreover, tom Dieck and Jung [38] demonstrates that AR could persuade children to visit museums while teachers enjoy the opportunity to have interactive visits that might trigger students' interest in history. An increasing number of scholars have contributed evidence that AR improves learning in different museum contexts, such as art [21,39,40], science [36,41], history [13], or natural history [42,43].

Although, museums are currently trying to project their educational role to young audiences, it is considered that this particular public is eager for a sensorial challenge, empathy, entertainment, emotion, and authenticity, and AR could be the proper tool to facilitate this. First, scholars have started to emphasize the role of new technologies in enhancing empathy. Lee et al. [44] advocated enhancing the connection between new technologies and empathy, envisioning how sensors could help us understand users' emotions, VR enriches users' experience of the world, and AR helps users to

better share their experiences. In this regard, the authors proposed the introduction of a new AR device, called empathy glasses, to foster the experience of others' sensations and feelings, the awareness of being in the same environment with someone, or the visualization of virtual persons in the real world. Moreover, historical empathy is an important element of historical thinking. Endacott and Brooks [45] mapped *historical empathy* as the intersectional space of three concepts: historical contextualization, perspective taking and affective connection. There is evidence that AR technologies stimulate students' learning and their historical empathy [46], as museums need to adopt new methods of communication for heritage management [47].

Second, museums have started to combine their educational and cultural activities with activities inspired by the entertainment world [48]. In order to meet museums visitors' needs, it is important to stage the experiences they desire without ignoring the entertainment component [49]; thus, for the museum context, scholars encourage espousing the concept of *edutainment*, defined as the convergence of education and entertainment [50,51].

Third, museums offer a very diverse set of experiences to visitors [52] which might be visual, sensory, aesthetic, recreational, sociable, educational, celebrating or enchanting [53]. However, multisensory museums experiences are still few and far between [22]. In understanding the multisensory experience, it is important to note that cognition is not solely a process of the mind, but rather of the interplay between minds, bodies, and the environment [54]. Therefore, this sensorial experience can enhance the sense of immersion and absorption. Quadri-Felitti and Fiore [55] depicted immersion as becoming physically or virtually enveloped by an event, whereas absorption was defined as engaging one's mind. Regarding the types of immersion AR facilitates, scholars point to *temporal immersion* [56] and explain that *emotional immersion* is more immersive than *spatial immersion* [57].

These are some reasons why young audiences can accept that museums can be modern and innovative and have started to become ambassadors of museum exhibitions [58].

## 2. Materials and Methods

### 2.1. Theoretical Framework

In the service marketing field, the key role played by entertainment and emotion in communication with consumers is largely accepted. Thus, it was decided to nuance our approach by drawing upon two marketing theoretical models (see Figures 1 and 2). A combination model of the four realms of experience [59] was proposed with the classic environmentalist stimulus–response model [60].

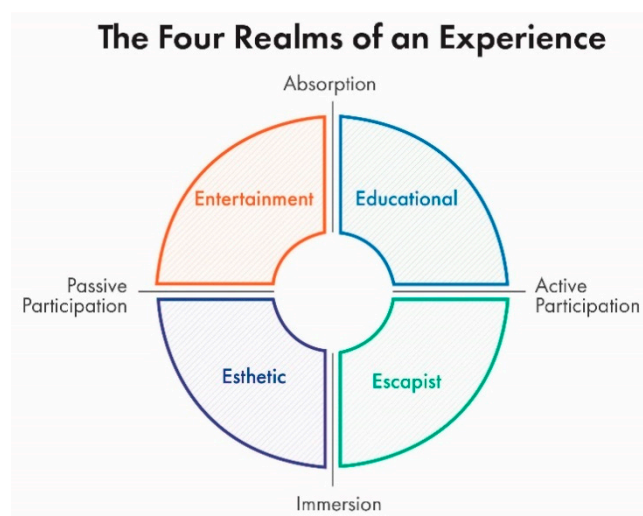
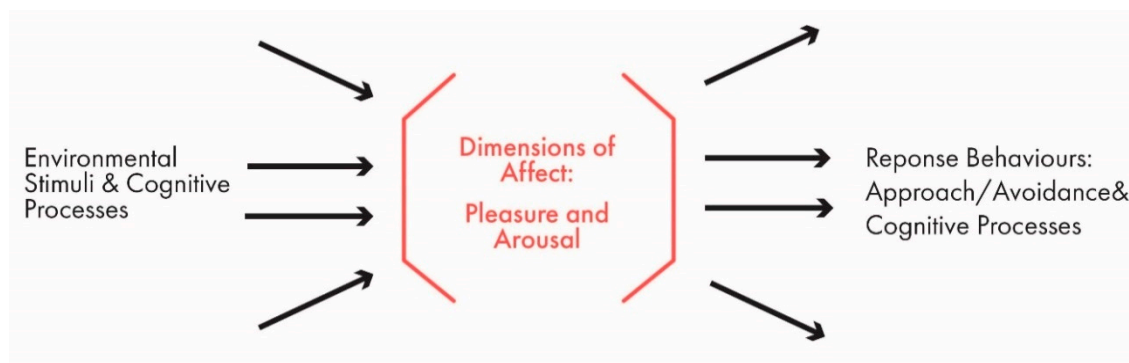


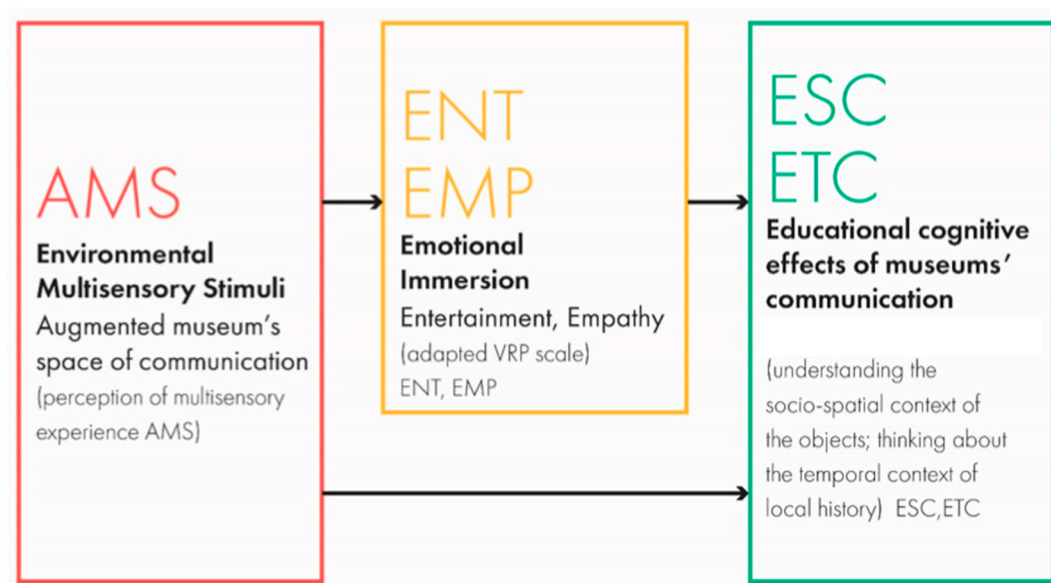
Figure 1. The 4Es of museum experience (Pine and Gilmore, 1998: 102).



**Figure 2.** The environmentalist stimulus–response model (Mehrabian and Russel, 1974).

Pine and Gilmore [59] defined consumer experiences in terms of an organization using “services as the stage and goods as props, to engage individual customers in a way that creates a memorable event”. From this model, we retained *entertainment* and *education*. Regarding the second model, in our model, environmental stimuli became *AR multisensory stimuli* while *response behaviors* became *cognitive processes with educational effects*. Based on the stimulus–response model, we hypothesized that the mediators of this relationship are entertainment and empathy.

It was conjectured that museum exhibitions using multisensory AR technologies can make young audiences think about the socio-historical context by enhancing their capacity to trigger entertainment and empathy. Therefore, our first hypothesis is that, in the process of augmenting museum communication services with young audiences using AR technologies, the degree to which museum visitors perceive they had a multisensory experience (augmented museum’s space of communication, AMS) influences the degree of understanding the socio-spatial context of the exhibited objects (ESC) and the propensity to think about the temporal context of local history (ETC). The second hypothesis is that the direct effect supposed above is mediated by the perceived degree of entertainment (ENT) and empathy (EMP) provided by the AR technology medium. In brief, we searched for evidence in favor of the model that AR technologies as environmental multisensory stimuli produce cognitive responses through emotional immersion (see Figure 3).



**Figure 3.** The proposed conceptual model of museums’ augmented communication. AMS: augmented museum’s space of communication; ENT: entertainment; EMP: empathy; ESC: socio-spatial context; ETC: temporal context.



## 2.2. Research Design

We conducted a cross-sectional exploratory quantitative study to assess the educational effects of the museum's communication services with young audiences after they experienced an exhibition with AR technologies. Primary data were collected in October 2017 by applying a survey based on a standardized questionnaire to students after they visited the permanent museum exhibition using AR technologies. The questionnaire was auto-administered with the help of research staff and took approximately 15 min to complete. For clarity, the questionnaire was pre-tested on students, and some items identified as too difficult to follow were rephrased. The AR museum exhibition was an experimental project carried out during a limited period (between August and November 2017) with a small number of beneficiaries. Therefore, to assess its effects, a purposeful sample of 400 museum visitors participating in the project from Braşov city, Romania was used (200 respondents attaining primary and secondary school education and 200 students with tertiary education;  $M = 17$  years old;  $SD = 3$  years).

Two stimulus–response marketing scale metrics, which are widely used to assess TV commercials, were adapted for AR experiences and validated [61].

## 2.3. Measurements

A cross-sectional exploratory quantitative study was conducted to assess the educational effects of museum communication services with young audiences after they experienced the exhibition.

Three concepts were measured (environmental multisensory stimuli, emotional immersion, and cognitive response behavior), using five indicators: the augmented museum's space of communication (AMS), entertainment (ENT), empathy (EMP), educational effects regarding the socio-spatial context (ESC), and educational effects regarding the temporal context (ETC). All the variables included in the models were measured on a 5-point Likert scale (where 5 means “strongly agree” and 1 “strongly disagree”).

The concept of **environmental multisensory stimuli** was operationalized using one indicator, namely **augmented museum's space of communication** (AMS). To measure AMS, the following question was asked “Our exhibition offers a series of experiences created with the help of AR and VR technologies. We would like to know how did you perceived them (...) It stimulated many of my senses simultaneously”.

The concept of **emotional immersion** was operationalized using two dimensions, namely **entertainment** (ENT) and **empathy** (EMP). Both dimensions were measured by using a revised version of the Viewer Response Profile (VRP) scale (Schlinger, 1979) adapted for the AR environment. VRP is a typical instrument for assessing reactions to marketing stimuli, with 32 items grouped in 7 dimensions (two of which being Entertainment and Empathy). In the original scale, Entertainment is defined as the degree to which a particular stimulus is pleasurable, enjoyable, and fun to watch, and Empathy is the degree to which the viewer lives the events, feelings and behaviors from the stimulus in a way that is experienced in the imagination through the actions of another person. To measure ENT, we reformulated the items as follows: “What I saw and heard was lot of fun” (ENT1); “The way it was presented was clever and entertaining” (ENT2); “Such an experience full of enthusiasm is catching—it's uplifting” (ENT3); “It wasn't just about exhibiting objects—it was entertaining and I appreciate that” (ENT4); “The information presented with such technologies captured my attention” (ENT5); “It's the kind of experience that keeps running through your mind after you've left” (ENT6); “It entertained me—I thought it was a very funny and pleasant experience” (ENT7). For this dimension, the reliability was very high (Cronbach's Alpha = 0.898).

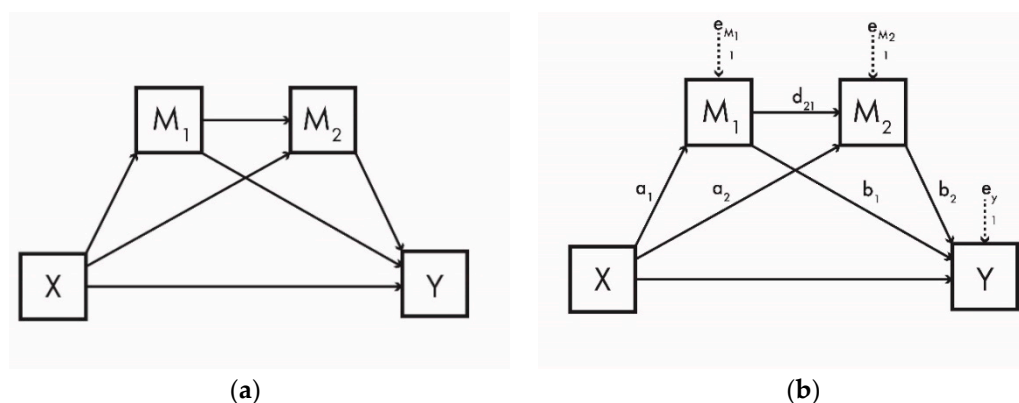
To measure EMP, we used the following items: “The experience was very realistic—that is the virtual objects and characters seemed real” (EMP19); “Experiencing the new technologies made me feel as if I were outside the museum” (EMP20); “I felt as though I was some other place experiencing the same thing as those from the short movies I was exposed to” (EMP21); “I would like to use such technologies in other context too” (EMP22); “The experience moved something inside me, I felt it as

something personal and intimate” (EMP23). For this dimension, the reliability was also very high (Cronbach’s Alpha = 0.82), but based on factor analysis results (presented in detail in the Results section), it was decided to eliminate EMP22, and the reliability increased (Cronbach’s Alpha = 0.84).

The concept of cognitive response behavior was operationalized using two indicators: educational effects regarding the socio-spatial context (ESC) and educational effects regarding the temporal context (ETC). To measure ESC and ETC, the following questions were asked: “To what degree do you agree or not that, after visiting the exhibition, you reached the following conclusion (...): I understood better the context from which the exhibited objects came from” (ESC); (...) “The experience stimulated me to think more intensely about local history” (ETC).

#### 2.4. Statistical Analysis

The data were analyzed using IBM SPSS Statistics (version 21, Armonk, NY, US). To validate the two revised sub-scales (based on the Empathy and Entertainment dimensions from VRP), the internal consistency of the construct was assessed by computing the Cronbach’s Alpha and running an exploratory factor analysis following Hayes [62]. To test the hypotheses, we conducted a multiple linear regression analysis. To estimate the direct and indirect effects of multiple mediator models, an ordinary least squares (OLS) regression path analysis modelling tool for SPSS (PROCESS v2.16) was used to test a serial multiple mediator model with two mediators (see Figure 4) [63].



**Figure 4.** (a) diagram for the model; (b) Statistical diagram for the model [63], p. 446. Note: in our first model, X is AMS, M1 is ENT, M2 is EMP, and Y is ESC; in our second model, X is AMS, M1 is ENT, M2 is EMP, and Y is ETC.

### 3. Results

The univariate statistics analysis shows that most of the respondents strongly agree that they would like to use AR technologies in other contexts, that the information presented with such technologies captured their attention, and that it is the kind of experience that they vividly remember after leaving the museum (see Table 1). On the other hand, the highest strong disagreement was reported for the emotional component of the experience (“The experience moved something inside me, I felt it as something personal and intimate”).

**Table 1.** Univariate analysis of all the variables included in the models.

Variable	Relative Frequency (%)					Mean	Standard Deviation	Valid Cases
	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree	M	SD	N
AMS	6.0	12.6	22.9	28.7	29.7	3.6	1.2	397
ENT1	2.5	4.5	23.8	35.0	34.3	3.9	1.0	400
ENT2	2.5	5.3	14.6	32.9	44.7	4.1	1.0	398
ENT3	1.5	7.0	15.8	26.6	49.1	4.1	1.0	399
ENT4	2.5	3.8	12.2	29.4	52.0	4.2	1.0	395
ENT5	2.5	5.8	9.8	27.1	54.8	4.3	1.0	398
ENT6	3.0	3.8	11.5	27.1	54.6	4.3	1.0	399
ENT7	2.8	6.4	22.2	30.9	37.8	3.9	1.0	392
EMP19	4.0	8.1	17.7	27.0	43.2	4.0	1.1	396
EMP20	6.9	11.4	25.4	23.6	32.7	3.6	1.2	394
EMP21	6.9	12.7	20.1	28.2	32.2	3.7	1.2	394
EMP22	2.8	6.1	12.2	22.5	56.5	4.2	1.1	395
EMP23	17.2	16.9	29.5	15.2	21.2	3.1	1.4	396
ESC	2.8	5.8	17.0	34.0	40.4	4.0	1.0	394
ETC	5.3	8.8	21.3	31.6	33.1	3.8	1.1	399

### 3.1. Scale Validation Analysis

For the **Entertainment** construct, the reliability is very high (Cronbach's Alpha = 0.898), and it would not increase if any of the items were deleted (see Table 2).

**Table 2.** Reliability analysis for the Entertainment dimension of the Viewer Response Profile (VRP) adapted scale.

Item	Scale Mean If Item Deleted	Scale Variance If Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha If Item Deleted
ENT1	25.00	23.667	0.690	0.884
ENT2	24.81	23.286	0.717	0.881
ENT3	24.79	22.773	0.766	0.875
ENT4	24.68	23.304	0.738	0.878
ENT5	24.67	23.435	0.692	0.884
ENT6	24.66	23.677	0.680	0.885
ENT7	24.98	23.753	0.628	0.891

For the **Empathy** construct, the reliability is also very high (Cronbach's Alpha = 0.819), but it would increase (Cronbach's Alpha = 0.839) if EMP22 were deleted (see Table 3).

**Table 3.** Reliability analysis for the Empathy dimension of the VRP adapted scale.

Item	Scale Mean If Item Deleted	Scale Variance If Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha If Item Deleted
EMP19	14.62	14.631	0.636	0.777
EMP20	14.93	13.410	0.708	0.754
EMP21	14.91	13.294	0.729	0.747
EMP22	14.34	16.838	0.397	0.838
EMP23	15.53	13.536	0.602	0.789

To validate the constructs and test the convenience of deleting EMP22, we conducted an exploratory factor analysis using Principal axis factoring as the extraction method with Oblimin rotation (as it was assumed that factors are correlated), including all the 12 items in the model. The Kaiser–Meyer–Olkin



test confirmed the sample is adequate ( $KMO = 0.923$ ), and the results of Bartlett's Test of Sphericity were statistically significant ( $\chi^2(66)=2278.3$ ,  $Sig.=0.000$ ). The Communalities Table (see Table 4) confirmed that EMP22 has the lowest common variation with the factors (0.314). Therefore, EMP22 was eliminated, and the factor analysis was rerun on the remaining 11 items (see Table 5). The two tests provided similar results ( $KMO=0.920$ ;  $\chi^2(55)=2159.3$ ,  $Sig.=0.000$ ). The Communalities Table shows that all the items have a common variation with the factors  $>0.4$ .

**Table 4.** The proportion of each variable's variance that can be explained by the factors.

Item	Model with EMP22		Model without EMP22	
	12 Items		11 Items	
	Initial	Extraction	Initial	Extraction
ENT1	0.506	0.510	0.510	0.521
ENT2	0.571	0.581	0.573	0.594
ENT3	0.613	0.639	0.618	0.663
ENT4	0.566	0.622	0.569	0.629
ENT5	0.530	0.541	0.516	0.531
ENT6	0.509	0.537	0.512	0.538
ENT7	0.473	0.467	0.449	0.451
EMP19	0.539	0.539	0.518	0.526
EMP20	0.575	0.669	0.575	0.674
EMP21	0.586	0.732	0.582	0.724
EMP22	0.314	0.310	-	-
EMP23	0.404	0.450	0.398	0.449

Extraction Method: Principal Axis Factoring.

**Table 5.** Total variance explained of the two identified factors using a Factor Analysis of the 11 items from the VRP adapted scale.

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings <sup>a</sup>
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	5.847	53.153	53.153	5.427	49.332	49.332	5.079
2	1.270	11.544	64.697	0.875	7.951	57.284	4.113
3	0.669	6.082	70.779				
4	0.569	5.170	75.949				
5	0.495	4.498	80.447				
6	0.486	4.421	84.868				
7	0.432	3.929	88.797				
8	0.350	3.181	91.979				
9	0.329	2.991	94.970				
10	0.281	2.559	97.529				
11	0.272	2.471	100.000				

Extraction Method: Principal Axis Factoring. <sup>a</sup> When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

The Total Variance Explained Table confirmed the concept (Emotional Immersion) is composed of two latent factors which explain 57% of its variation (49% for the first factor, and 8% for the second one).

The structure and pattern matrix show that, in the Entertainment factor, the items with the highest loadings are ENT3 ("Such an experience full of enthusiasm is catching—it picks you up") and ENT4 ("It wasn't just about exhibiting objects—it was entertaining and I appreciate that"), in the Empathy factor, the items with the highest loadings are EMP21 ("I felt as though I was some other place experiencing the same thing as those from the short movies I was exposed to") and EMP20 ("Experiencing the new technologies made me feel as if I were outside the museum").

For the two identified factors, corresponding to the two dimensions from the VRP scale, Entertainment and Empathy, we calculated the factorial score using the Bartlett method. We chose this

method as it provides high validity (see Table 6; estimates that are most likely to represent the true factor scores; unbiased estimates of factor score parameters) [64].

**Table 6.** The structure of the two constructs (Entertainment and Empathy) based on the relationships between items and factors.

Item	Factor Matrix *		Pattern Matrix **		Structure Matrix ***	
	Factor		Factor		Factor	
	1	2	1	2	1	2
ENT1	0.711	−0.124	0.649	0.104	0.718	0.534
ENT2	0.736	−0.228	0.785	−0.021	0.770	0.498
ENT3	0.789	−0.201	0.793	0.033	0.814	0.557
ENT4	0.744	−0.274	0.842	−0.076	0.791	0.481
ENT5	0.706	−0.181	0.710	0.028	0.729	0.498
ENT6	0.690	−0.248	0.774	−0.063	0.732	0.449
ENT7	0.665	−0.095	0.584	0.123	0.665	0.510
EMP19	0.699	0.195	0.281	0.508	0.618	0.694
EMP20	0.695	0.436	0.008	0.816	0.548	0.821
EMP21	0.708	0.473	−0.025	0.867	0.549	0.851
EMP22	0.559	0.370	−0.016	0.681	0.434	0.670

Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization. \* the correlations between the variable and the factor. \*\* partial standardized regression coefficients between the variable and the factor (the unique contribution of a factor to an item while controlling for the effects of other factors on that item). \*\*\* zero-order correlations between factors and variables (the strength of the relationship between the item and the factor while ignoring the relationship of that factor with all the other factors).

### 3.2. Mediation Analysis

We tested two mediation models—one for every communication effect—i.e., ESC (Model 1) and ETC (Model 2) (see Tables 7–9).

**Table 7.** Regression Coefficients, Standard Errors, and Model Summary Information for the presumed influence of the Augmented Reality (AR) multisensory experience on understanding the socio-spatial context of the artefacts exhibited in the museum in a serial multiple mediation model.

Antecedent	Consequent											
	$M_1$ (ENT)				$M_2$ (EMP)				Y (ESC)			
		Coeff.	SE	$p$		Coeff.	SE	$p$		Coeff.	SE	$p$
X (AMS)	$a_1$	0.488	0.035	0.000	$a_2$	0.240	0.040	0.000	$c'$	0.184	0.044	0.000
$M_1$ (ENT)	-	-	-	-	$d_{21}$	0.464	0.049	0.000	$b_1$	0.432	0.056	0.000
$M_2$ (EMP)	-	-	-	-	-	-	-	-	$b_2$	0.153	0.054	0.005
Constant	$i_{M_1}$	-1.761	0.134		$i_{M_2}$	-0.874	0.152	0.000	$i_Y$	3.348	0.163	0.000
	$R^2 = 0.350$				$R^2 = 0.451$				$R^2 = 0.457$			
	F (1360) = 193.898, $p = 0.000$				F (2359) = 147.300, $p = 0.000$				F (2359) = 100.286, $p = 0.000$			

**Table 8.** Decomposing the total effects of the AR multisensory experience on understanding the socio-spatial contexts of the artefacts exhibited in the museum.

Type of Effect	Path	Effect
Total effects	AMS→ESC	0.466
Direct effect	AMS→ESC	0.184
Total Indirect effects	AMS→ESC	0.282
Indirect effect of the entertainment path	AMS→ENT→ESC	0.211
Indirect effect of the emotional path	AMS→ENT→EMP→ESC	0.035
Indirect effect of the empathy path	AMS→EMP→ESC	0.037

**Table 9.** Regression Coefficients, Standard Errors, and Model Summary Information for the presumed influence of the AR multisensory experience on stimulating thinking about local history in a serial multiple mediation model.

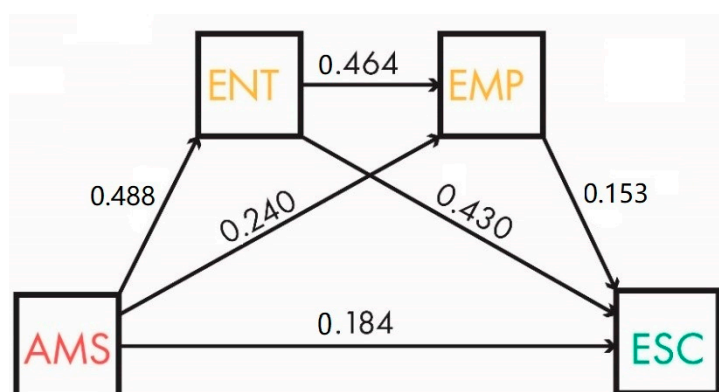
Antecedent	Consequent											
	$M_1$ (ENT)				$M_2$ (EMP)				Y (ETC)			
	Coeff.	SE	$p$		Coeff.	SE	$p$		Coeff.	SE	$p$	
X (AMS)	$a_1$	0.483	0.035	0	$a_2$	0.243	0.040	0	$c'$	0.299	0.252	0.000
$M_1$ (ENT)	-	-	-	-	$d_{21}$	0.460	0.049	0	$b_1$	0.113	0.068	0.095
$M_2$ (EMP)	-	-	-	-	-	-	-	-	$b_2$	0.300	0.065	0.000
Constant	$i_{M_1}$	-1.745	0.134	0	$i_{M_2}$	-0.884	0.150	0	$i_Y$	2.679	0.196	0.000
	$R^2 = 0.344$				$R^2 = 0.449$				$R^2 = 0.341$			
	F (1360) = 190.713, $p = 0.000$				F (2359) = 147.302, $p = 0.000$				F (2359) = 62.392, $p = 0.000$			

### 3.2.1. Model 1

The regression table shows that regressing EMP or ESC on AMS and ENT gives the most accurate prediction.

The path diagram shows that for the emotional path (AMS→ENT→EMP→ESC), the strongest predictor is AMS (for ENT); for the entertainment path (AMS→ENT→ESC), the strongest predictor is AMS (for ENT); for the empathy path (AMS→EMP→ESC), the strongest predictor is AMS (for EMP).

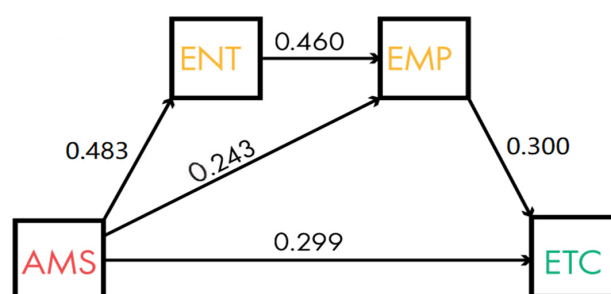
By decomposing the total effects of the AR multisensory experience on understanding the socio-spatial contexts of the artefacts exhibited in the museum, it was found that indirect effects are stronger than direct effects, and among the indirect effects, the entertainment path accounts for the strongest impact (see Figure 5 and Table 8).

**Figure 5.** Path diagram of the influence of the AR multisensory experience on understanding the socio-spatial context of the artefacts exhibited in the museum through entertainment and empathy (with regression coefficients).

### 3.2.2. Model 2

The table shows that regressing EMP on AMS and ENT gives the most accurate prediction.

The path diagram (see Figure 6) shows that for the emotional path (AMS→ENT→EMP→ETC), the strongest predictor is AMS (for ENT); the entertainment path (AMS→ENT→ETC) is not statistically significant; and for the empathy path (AMS→EMP→ETC), the strongest predictor is EMP (for ETC).



**Figure 6.** Path diagram of the influence of the AR multisensory experience on stimulating thinking about local history through entertainment and empathy (with regression coefficients).

By decomposing the total effects of the AR multisensory experience on stimulating reflection about local history, it was found that direct effects are stronger than indirect effects, and among the indirect effects, the empathy path accounts for the strongest impact (see Table 10).

**Table 10.** Decomposing the total effects of the AR multisensory experience on stimulating thinking about local history.

Type of Effect	Path	Effect
Total effects	AMS→ETC	0.438
Direct effect	AMS→ETC	0.299
Total Indirect effects	AMS→ETC	0.194
Indirect effect of the emotional path	AMS→ENT→EMP→ETC	0.067
Indirect effect of the empathy path	AMS→EMP→ETC	0.073

## 4. Discussion

It was hypothesized that the augmented museum space of communication has cognitive educational effects on young audiences mediated by entertainment and empathy. First, we validated the two constructs of entertainment and empathy. Second, we confirmed the hypothesis that the AR multisensory experience has direct effects on both understanding the socio-spatial context of the artefacts exhibited in the museum and stimulating thinking about local history. Third, it was shown that the strongest indirect path from the AR multisensory experience to understanding the socio-spatial context of the artefacts exhibited in the museum is through entertainment. Fourth, it was revealed that the strongest indirect path from the AR multisensory experience to stimulating thinking about local history is through empathy. Fifth, while our models also support the idea that the indirect path from the AR multisensory experience to understanding the socio-spatial context of the artefacts can also result from empathy (although this indirect effect is weaker), they do not support the idea that the indirect path from AR multisensory experience to stimulating thinking about local history is through entertainment (the influence is not statistically significant). Sixth, both models support the idea that indirect effects could take a more complex path: going first through entertainment, and then through empathy (although these indirect effects are weaker).

On the one hand, entertainment facilitates the contribution of the AR multisensory experience to understanding the daily life from which the museum's artefacts originate. Primarily, the highest

loadings of the items in the entertainment factor show that the encoding of the historical message for young audiences can be optimized by focusing on creating an engaging experience full of enthusiasm and circumventing the traditional approach of passively exhibiting objects. Secondly, generating enthusiasm also means surprising visitors with intelligent displays, making them feel good, encouraging them to have fun, capturing their attention, and crafting memorable experiences.

On the other hand, empathy allows for the transition from an AR multisensory experience to thinking about the wider context of local history. The highest loadings of the items in the entertainment factor show that the encoding of the historical message can be optimized by immersing the visitors into a different space and different time (anchored outside the museum, in the past), making them emphatically experience various historical circumstances. Additionally, this means creating a sense of authenticity, the feel of “real life”, and focusing on alleviating emotions and intimate links with the historical content. Therefore, in augmented museum communication, empathy is a combination of immersion and escapism. It implies staging an augmented space and an augmented time, allowing visitors to escape from the present ones and become immersed in the past. This medium of communication seems similar to virtual reality, but in augmented reality, the connection with the present space and time involves triggering the feeling of authenticity.

Entertainment alone only functions in the small spatial context of the exhibition; it cannot stimulate thinking about the wider temporal historical context unless it is orchestrated to produce empathy. If this goal is achieved, not only would young audiences think more about the cultural–historical context, but also they would understand better the micro-context of social or family life from which the artefacts originate.

These results converge to suggest that, in the augmented museum space of communication, emotional immersion mediates the effect of the environmental multisensory stimuli on the cognitive response behavior. If the cognitive response behavior refers to the understanding of the socio-spatial context of the museums’ artefacts, the emotional immersion could be attained by enhancing the entertainment component of the visiting experience. If the cognitive response behavior refers to thinking about the temporal context of local history, the emotional immersion could be reached by stimulating the empathy dimension of the visiting experience.

Our results challenge the assumption that museum communication services with young audiences using modern technologies such as AR involve simply creating a multisensory experience to meet educational goals, as this does not result in obtaining cognitive responses from sensorial AR stimuli. Hence, an intervening emotional mechanism was revealed in which perception has cognitive effects through entertainment and empathy.

The settings designed to valorize cultural heritage through AR experiences aim to offer visitors a pleasant and unforgettable experience in a limited time frame. They can be used as efficient communication mediums with various target audiences, especially youth segments [65]. In an increasingly competitive and globalized world, museums are starting to take into account the sustainable dimension of their development strategy. Hence, attracting young audiences can become an important component of their marketing programs. In a broader sense, the key principle of sustainable development refers to integrating environmental, social and economic concerns into all aspects of museum decision processes [66]. From an environmental perspective, using AR could reduce the usage of traditional and energy-consuming solutions for heritage interpretation, such as leaflets, panels, cardboards, or plastic displays. From an economic perspective, attracting young audiences could provide flows of visitors in the long term. Moreover, AR can have a positive impact on reducing operational costs for museums for temporary or permanent exhibitions as less material and rooms for exhibitions or for deposits will be needed. As regards the social pillar of sustainability, it is important to note that for activities in the age of ubiquitous smart phones, increasing types of social categories are at risk of being excluded from participating in social goods and cultural activities. By designing a visiting experience in which the technologies are already provided, museums have the chance to use this communication platform to reach increasingly diverse audiences.



## 5. Conclusions

This study was designed to explore ways to improve a museum's communication services with young audiences using AR technologies. The main findings are that the multisensory augmented museum space of communication can enhance (1) entertainment, to help young audiences to decode the message from the narrow context from which the artefacts were collected; and (2) empathy, to stimulate young audiences to decode the message from the wider context of local history. Staging an AR multisensory communication experience that embodies both entertainment and empathy could help to meet both educational aims, on the condition that entertainment triggers empathy. From a theoretical perspective, we tried to advance the knowledge in the field of communication by considering the marketing approach. From a managerial perspective, this study could help museum professionals and application developers to bridge AR implementation as a communication service tool with user experience. All considered, we recommend that museum professionals ask developers of AR applications to take into account the role of entertainment and empathy in order to maximize the educational communication effects and add a positive experience to young visitors.

### *Limitations of the Study*

Since the research was bounded by the stimuli included in a specific experimental project, it was not possible to create complete multisensory AR experience. Moreover, one might question our categorization of the experience as an AR one, as some specific functional differences between VR and AR might have been ignored. The conceptualization was based on the fact that there is not a definite answer to the conceptual difference between AR and VR and that, in accordance with the respondents, the authors do not appreciate that the experimental devices transpose users in another reality. However, the stimuli were described in detail in the Introduction section, meaning that readers can understand what we mean by AR in this study. The most important limitation lies in the fact that the survey was applied only to the beneficiaries of the project. Therefore, our conclusions are only transferable to similar AR application contexts. Also, the study does not take into account the possible influence of museum's staff on the visiting experience, as guides are service provider employees shown in the literature to impact the intention to adopt technology-facilitated services [67]. Even so, the strength of the research lies in its potential for future reproducibility, as we generated a reliable instrument, described in detail that could be used to test the role of entertainment and empathy, in the future, in various contexts with various AR stimuli. It is clear that entertainment and empathy should not be ignored in assessing the educational effects of a museum's communication with young audiences through AR technologies; however, more studies are needed to assert a precise emotional mechanism allowed by more complex AR settings with more complex educational goals. A greater focus in the future on the communication role of AR as an immersive medium or as an informational channel could produce further developments that account more for museums visitor satisfaction.

Even if, from the follow-up meetings with students and museum's staff, the augmented communication was perceived to be a success, hard data are difficult to provide due to contextual limitations. It would have been useful to complement our analysis with quantitative data regarding the specific increase of young visitors after the AR intervention. However, the structure of the museum's visiting space and the patterns of collecting visitor data make it almost impossible to provide this information. Less than 25% of the spaces designed for exhibitions are allocated for the permanent section in which the AR solution was implemented, while the main drivers for visitors are the 3–5 temporary exhibitions organized yearly. Nevertheless, the positive impact of the AR intervention and its dimensions emerged from the qualitative data that we have collected (from museum staff observation and the book of impressions records). The most pervasive themes that we extracted from these data suggest that the AR experience made young audiences focus on the “fresh and modern” dimension of the museum, the way in which the experience was “perfectly matched with the modern”; “the very interesting modern interface” of the museum; “the interesting and interactive visit and the digital interactions in the museum as unique experiences”.

Regarding measurements, although the proposed scale used in this study to measure the museum's visitor experiences is an adapted version of an already validated one that has been in use for almost five decades, one might question the suggestibility of specific items. On the one hand, our research had to overcome linguistic differences. By closely translating specific items of the scale from English, there were cases in which the Romanian formulation contained a double negation. Although these versions of the items lacked suggestibility, after the pre-test, students told us that they found them difficult to understand and experienced cognitive load, especially when they had to process a disagreement with a double negation. Hence, we decided to reword them into an affirmation to avoid confusion. On the other hand, this was strongly supported by the museum staff, who specifically suggested that we reformulate questions so that they would not cognitively overburden respondents or artificially put their audience in a negative state for which they have designed an emotional, positive and easy-to-process visiting experience. However, this was not the case for all the items, because after multiple negotiations, we managed to maintain some very specific negative items in the scale. Consequently, it will be important for future studies measuring multisensory AR experience to take into account both cross-cultural linguistic differences and institutional barriers for exposing audiences to negative and difficult statements.

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